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THE EFFECT OF BILE ON THE VIABILITY AND GENERAL BIOLOGY OF INTESTINAL PATHOGENIC BACTERIA

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INTRODUCTION

The purpose of this investigation was mainly threefold. Being an extension of the senior author's previous experiments and experience(1, 2, 4) the present investigation was intended to elucidate some of the problems bearing on bacterial carriers.

Consequently the viability of pathogenic intestinal bacteria in bile was investigated first as the fundamental problem of the carrier state and at the same time as a practical method for the preservation of pure cultures for a long time without transplanting them.

The other main question was what changes, if any, in their biological properties, cultures of the intestinal bacteria undergo when living in bile and transplanted not by plating, but in a way that is customary in maintaining stock cultures.

DISCUSSION AND DESCRIPTION OF THE METHOD USED

The frequency with which the cholera vibrio is found in the human gall bladder at autopsy, the ease with which it is recovered therefrom, while cultures from the intestines not infrequently fail, and the observation first made by Otolenghi(3) that bile is an excellent enrichment medium for the cholera vibrio, led the senior author, years ago, to use bile for the preservation of cholera stool specimens for delayed examination in the Tropics. During the investigation undertaken in this connection it was found that the majority of freshly isolated strains of the cholera vibrio survive in pure culture in the bile in vitro for a remarkably long time—that is, for a year or more—at room temperature in the Tropics (average 28° C.) without being transplanted. It was found that they preserve well their shape, motility, and antigenic property under such conditions. In the light of experience accumulated during a period of over ten years the author felt justified in preserving in bile cholera cultures particularly selected to be used for the preparation of vaccine and serum.(4) The unexpectedly long viability of the cholera in sea water(1) suggested the mixture of bile and salt solution for this purpose.

Although bile medium is found on a regular list of ordinary culture media, in spite of the fact that it was recommended as an enrichment medium long ago and notwithstanding the fact that it has been used in diagnosis of typhoid fever for blood culture and applied in the studies of bacterial dissociation, for instance by S. Takano,(5) comparative tests on the viability of intestinal pathogenes and the changes that may take place in their biology when transplanted "en masse," to our best knowledge, have not been carried out. Yet this question is of practical significance.

VIABILITY OF INTESTINAL PATHOGENIC BACTERIA IN BILE

THE CULTURES

The cultures used for these experiments originated from the Imperial Army Medical School, Tokyo, and were typical strains of *Bacillus coli*, *B. paratyphosus* A and B, *B. typhosus*, and *B. dysenteriæ* Shiga-Kruse, Y, and Flexner. We are greatly indebted to Col. H. Hirano for sending them to us. These strains became well known to us, since they are the same cultures that had been used in our experiments concerning the usefulness of eosin-methylene-blue glycerin agar for differentiation of intestinal bacteria.(5)

PROCEDURE

Pure cultures of these strains in peptone water were used as the seed from which test tubes containing bile in concentrations ranging from 5 per cent to 50 per cent were inoculated. The diluent of bile was salt solution. The inoculated bile cultures were kept in the dark at room temperature. The experiment was started in July, 1933, and carried on throughout the whole year, so that the bacteria concerned were exposed to the action of bile at the various temperatures prevailing through the four seasons of the year without being transplanted.

About once a month their viability was tested by planting one or two loopfuls of the respective bile cultures into peptone water. The identity of the cultures thus obtained was assured by adding to the peptone cultures specific immune serum and observing agglutination.

From time to time the strains were tested for their biologic properties by planting them on the surface of lactose, glucose, saccharose, maltose, and mannite, eosin-methylene-blue, agar plates, placing a small loopful into each segment marked on the outside bottom of the plate.

THE RESULTS OF VIABILITY TESTS

The length of survival in bile of the intestinal bacteria under test is evident from Table 1.

It is hardly a coincidence that the intestinal bacteria which during natural infection invade the gall bladder and remain there alive for a considerable time, thus causing the carrier state, survived in bile in vitro the longest time.

Another noteworthy observation is that the concentration of bile in salt solution had little if any effect on the viability of the bacteria tested.

Since the purpose was not to search for dissociation phenomena, but to preserve the cultures in their original state as long as possible, the bile cultures were not plated out, but transferred to peptone water "en masse" as is customary in transferring stock cultures.

THE EFFECT OF TEMPERATURE ON THE SURVIVAL OF INTESTINAL BACTERIA IN BILE

As was to be expected from general experience, the factor of exposure temperature exerted considerable influence on the viability of the intestinal pathogenes in bile. The bacteria in question survived much longer at 14° C. than they did at 37° C., the time relation between the various kinds of bacteria being the same.

THE EFFECT OF CHEMICAL REACTION ON THE SURVIVAL OF INTESTINAL BACTERIA IN BILE

Three lots of 20 per cent bile in salt solution were adjusted at different pH values, 7.6, 7.2 and 6.8, placed in tubes, sterilized, planted with the strains of bacteria under test, and left at room temperature in the dark. Tests for viability were performed in the way already described, at weekly intervals.

While the temperature factor affected all cultures in the same way the various kinds of intestinal pathogenes showed, to a certain degree, a selectivity with regard to the three pH values employed.

Bacillus coli and *B. paratyphosus* B both showed a remarkable tolerance to the various degrees of acidity and survived in bile under these conditions throughout the entire test; that is, at least 93 days.

Bacillus typhosus lived in bile at pH 7.2 and 7.6 for 56 days and at pH 6.8 only 49 days.

Bacillus paratyphosus A's optimum proved to be towards the acid end inasmuch as it survived for 74 days at pH 6.8, for 93 days at pH 7.2, and only 14 days at pH 7.6.

The dysentery strains showed very low viability in bile in this case, the best being that of dysentery Y at pH 7.2. The details of this test are given in Table 2.

THE EFFECT OF BILE ON THE BIOLOGIC PROPERTIES OF INTESTINAL PATHOGENIC BACTERIA AS REVEALED BY FERMENTATION TESTS

In the course of the experiment discussed in the preceding section the cultures that had been obtained by planting the inoculated bile into peptone water from time to time were tested for their fermentative properties.

The technic mentioned in the preceding section and described on other occasions was used and the results were read in 24 and again in 48 hours. They are tabulated in Tables 3 to 7.

RESULTS OF FERMENTATION TESTS PERFORMED ON INTESTINAL BACTERIA THAT HAVE BEEN KEPT IN BILE FOR VARIOUS LENGTHS OF TIME.

On the whole the results show that the majority of the cultures tested preserved their fermentative characteristics intact for a long time. They prove that, although some of the bacterial cells in the respective cultures may have undergone a change, the majority of them retained the characteristics of the mother culture.

One thing seems to be noteworthy in this connection; namely, the findings with regard to *B. dysenteriæ* Y (Table 3). This strain, after it had been exposed to the action of bile for seven months and shortly before it died out, apparently lost its power to ferment mannite but preserved its power to decompose glucose. Serologic tests, however, proved this strain to be a Y strain, although the fermentation tests placed it in the Shiga-Kruse class. Another phenomenon was observed in the course of these tests; namely, that the *B. coli* and *paratyphosus* strains fermented the sugars that they should, although in a rather sluggish way, towards the end of one year's exposure to bile.

As a continuation of this investigation the following experiment was carried out: Such strains from the first experiment as survived for one and one-half years in bile (*B. coli* and *B. paratyphosus* A and B) were transplanted directly from bile on eosin-methylene-blue agar plates, a small loopful having been placed on the surface of the agar without spreading it. Various carbohydrates having been added to this agar the fermentation reactions were observed. The carbohydrates were lactose, glucose, maltose, and mannite. Observations made after 24 and again 48 hours showed that none of these strains fermented maltose and some of them lost the power to ferment mannite, while the property of decomposing glucose was generally preserved as was shown by typical color reaction on the eosin-methylene-blue glucose-agar plate and by gas production in glucose agar.

The growth that appeared on the eosin-methylene-blue agar was then transplanted into peptone water and after these cultures had been incubated for 24 hours and allowed to stand at room temperature, a distinct spontaneous agglutination appeared in them, particularly strong in the case of *B. coli,* less so in the *paratyphosus* B cultures, and only slightly pronounced in the cultures of *B. paratyphosus* A. When tested after a few transplants for fermentative properties, these cultures had recovered their original power to decompose mannite, while that of splitting maltose was still impaired. On further transplanting, the spontaneous agglutination, which had been observed in the first few transplants and which in the appearance of the sediment resembled the acid agglutination, disappeared completely.

Besides transplanting in ordinary peptone water, as already mentioned, the cultures that had been exposed to the action of bile for sixteen months, direct transplants were made from the bile cultures into peptone water containing 1 per cent maltose. After one month elapsed, during which time ten transplants in this medium had been made, all of the cultures regained completely their power to decompose maltose.

Thus it is evident from this experiment that the ability on the part of the examined cultures to decompose glucose has remained unimpaired throughout their long sojourn in bile; while their fermenting power directed against mannite, which had been lost thereby, was rapidly regained upon cultivation in plain culture media, their former ability to ferment maltose did not recover by this procedure, but did so quite readily in peptone water containing 1 per cent maltose. This statement applies to the gas producers such as *B. coli* and the paratyphosi (Tables 8 and 9).

The restoration of these important biologic properties of the intestinal bacteria under test, which they originally possessed but lost after long contact with bile, is furthermore a proof that the biologic differences between the original cultures and those recovered long after from bile are not due to accidental contamination of the bile cultures.

Simultaneously with the loss of their power to ferment certain carbohydrates the cultures in question experienced a decided shifting of their location in the zones of the metabolic spectrum on eosin-methylene-blue glycerin-agar plates. The *B. coli* strain, the number of sugars which it fermented now being less, shifted into the zone where *B. paratyphosus* normally belongs. Thus the reddish tint, which the *B. coli* group usually produces on this medium, disappeared and the growth was of a brown color, showing that also the respiration had undergone a change due to the diminished rate of multiplication.

These findings seem to indicate the explanation of the ultimate recovery of normal conditions upon subsequent transplants at frequent intervals. These, so to speak, "en masse" dissociated cultures are mixed cultures of normal and dissociated bacterial cells in which the dissociated ones by far predominate. The bacterial cells that have dissociated multiply slower than normally, as shown by the luxuriance of growth and by shifting in the metabolic spectrum, which points to reduced respiration and possibly fermentative action and, consequently, they are soon overgrown by the cells that remained undissociated. Although originally in the minority these well-preserved bacterial cells multiply quicker than the dissociated ones, so that with repeated transplants at frequent intervals more and more of the normal cells are being transferred as a seed and the apparently dissociated culture, no plating being done but "en masse" transplants made, recovers even without the affected carbohydrate being supplied as a pabulum. This explanation seems to be the more plausible when the fact is considered that the dissociated cultures recovered more rapidly and completely when subcultivated in peptone water containing maltose than they did when grown in a plain culture medium. It is a well-known fact that bacteria grow more luxuriantly in a medium containing a carbohydrate which they decompose than in one containing a carbohydrate which they do not decompose, particularly if they possess any anaërobic tendency at all. Under the conditions of transplanting, as mentioned above, it depends, as in a contaminated culture, on the individual rapidity of growth, whether the mutant or the original type will ultimately predominate in the mixed culture.

CORRELATION OF THE APPARENT LOSS OF FERMENTATIVE PROPERTIES EVIDENCED ON EOSIN-METHYLENE-BLUE AGAR AND BY GAS PRODUCTION

In order to correlate the loss of fermentative properties of the strains concerned in the last experiment, which became apparent by the absence of the black color of growth on eosin-methylene-blue agar plates to which mannite or maltose had been added, with the actual fermentation as evidenced by gas production, and to arrive at an explanation of this phenomenon, another experiment was arranged.

As has been repeatedly demonstrated, the color reaction of the growth on the surface of this differential medium is due to at least two factors; besides the actual fermentation of the carbohydrate added to the medium, the absorption of atmospheric oxygen plays its rôle in the production of the black or brown color which appears within the mass of bacterial growth as a combination of eosin and methylene blue in the presence of acid produced by the bacteria with the help of atmospheric oxygen.

While the strains of *B. coli* and *paratyphosus* B and A that had been kept in bile for one and one-half years were tested on eosin-methylene-blue agar plates at monthly intervals, they were simultaneously inoculated into graduated fermentation tubes containing peptone water to which glucose, maltose, and mannite, respectively, had been added. Once a month this test was repeated and curves indicating the amount of gas by days were drawn. For the sake of brevity the numerous charts obtained in this manner are omitted and the discussion of results is limited to a brief summary: Of the three gas producers *B. paratyphosus* A was the weakest. The quantitative relations between the gas produced by each of them were constant though different with each kind of bacterium. The amount of gas produced by the same strain from different sugars differed greatly, but the relation of the amount of gas produced by the same bacterium from the various sugars remained constant.

At the time when the bile cultures, more than a year old now, having been planted on eosin-methylene-blue sugar-agar plates, failed to show black growth on maltose and mannite, no striking drop in the gas production was noticed; in certain instances there was rather an increase of gas production. The only apparent change in the gas curves was a delay of the maximum of gas production for a day or two, which phenomenon signifies, as has been proven in a special experiment, that the number of viable bacteria in the bile culture has diminished by that time (Table 8).

This disagreement of results obtained by eosin-methylene-blue sugar-agar plates and those arrived at by tests for gas production places the change of the color reaction on the eosin-methylene-blue plates into the category of those phenomena which had been studied on another occasion and had been designated as shifting of bacterial respiration.

CONCLUSIONS

1. Of the intestinal pathogenic bacteria—namely, *B. coli, B. typhosus, B. paratyphosus* B and A, and *B. dysenteriæ* Shiga-Kruse, Flexner, and Y—the four first-mentioned may survive in bile diluted with salt solution for a long time, a year or more, without being transplanted; *B. dysenteriæ* only a short time, and *B. paradysentericus* somewhat longer.

TABLE 1.—*The viability of intestinal pathogenic bacteria in bile.*

[Planted June 23, 1933. Tested at monthly intervals.]

Bacterium.	Dilution of bile with salt solution.			
	25 per cent.	20 per cent.	10 per cent.	5 per cent.
Bacillus coli	12	12	12	12
Bacillus paratyphosus B	12	12	12	12
Bacillus paratyphosus A	11	12	12	12
Bacillus typhosus	11	12	7	12
Bacillus dysenteriæ Flexner	9	12	9	12
Bacillus dysenteriæ Y	5	7	5	5
Bacillus dysenteriæ Shiga-Kruse	5	5	5	5

TABLE 2.—*The viability of intestinal pathogenic bacteria in bile at different* pH *concentrations. (Room temperature.)*

pH 7.6.

Bacterium.	Days of exposure.													
	1	14	21	28	35	42	49	56	62	68	74	80	87	93
Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus typhosus	+	+	+	+	+	+	+	+	+	—	—	—	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	+	+	+	+	+	+	—	—	—	—	—

pH 7.2.

Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus typhosus	+	+	+	+	+	+	+	+	+	+	+	+	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	+	+	+	+	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	+	+	+	+	+	+	+	+	+	—	—

pH 6.8.

Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	+	+	+	+	+	+	+	+	+	+	—	—	—
Bacillus typhosus	+	+	+	+	+	+	+	—	—	—	—	—	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	—	—	—	—	—	—	—	—	—	—	—

TABLE 3.—*Results of fermentation tests performed with cultures that had been exposed to the action of bile from June 23, 1933, until January 30, 1934; that is, for seven months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	20	+	+	+	+
Do	25	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Do	50	—	+	+	+
Bacillus dysenteriæ Flexner	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus dysenteriæ Y	20	—	+	—	—

TABLE 4.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to May 2, 1934; that is, about nine months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	20	—	+	+	+
Do	25	—	+	+	+

TABLE 5.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 28, 1933, to May 29, 1934; that is, about ten months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	10	+	+	+	+
Do	20	+	+	+	+
Do	25	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	60	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	5 and 25	—	+	+	+

TABLE 6.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 28, 1933, to June 28, 1934; that is, a little more than one year.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	10	+	+	+	+
Do	20	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	20	—	+	+	+

TABLE 7.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to September 13, 1934; that is, about fifteen months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.	Gas production glucose.
	Per cent.					
Bacillus coli	5	+	+	—	—	+
Do.	5	+	+	—	—	+
Do.	5	+	+	—	—	+
Bacillus paratyphosus B	50	—	+	+	—	+
Do.	50	—	+	+	—	+
Do.	50	—	+	+	—	+
Bacillus paratyphosus A	5	—	+	+	—	+
Do.	5	—	+	+	—	+

TABLE 8.—*Partial recovery of fermentative properties of the same cultures as given in Table 7 after the tenth transplant in peptone water. Included are the original strains that have never been in contact with bile.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.	Remarks.
	Per cent.					
Bacillus coli	5	+	+	+	+	----------
Do.	5	+	+	+	+ (?)	----------
Do.	5	+	+	+	—	----------
Bacillus paratyphosus B	50	—	+	+	+	Slow.
Do.	50	—	+	+	+	Slow.
Do.	50	—	+	+	—	----------
Bacillus paratyphosus A	5	—	+	+	+	----------
Do.	5	—	+	+	+	----------

ORIGINAL STRAINS.

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.	Remarks.
Bacillus coli	0	+	+	+	+	----------
Bacillus paratyphosus B	0	—	+	+	+	----------
Bacillus paratyphosus A	0	—	+	+	+	----------

TABLE 9.—*Complete recovery of fermentative properties toward maltose by the same cultures as given in Tables 7 and 8 after the tenth transplant in peptone water which contained 1 per cent maltose.*

Bacillus coli	1+
Do.	2+
Do.	3+
Bacillus paratyphosus B	1+
Do.	2+
Do.	3+
Bacillus paratyphosus A	1+
Do.	2+

2. There is no evidence to be gathered from our experiments that the degree of dilution of bile with salt solution has any effect on the viability of the bacteria in bile, but the temperature of exposure and the chemical reaction of the bile affect it considerably, though not the various kinds of bacteria to the same degree.

3. After they have been kept in bile for a long time and shortly before they die out, the entire cultures undergo certain changes, which are described. These changes are of a degenerative character; they are ephemeral and easily reparable changes caused by the lowered vitality of the bacteria concerned.

TABLE 10.—*The maximum gas production at different periods of exposure to the action of bile.*

Exposure.	Lactose.	Glucose.			Maltose.			Mannite.		
	Bacillus coli.		*Bacillus parathyposus B.*	*Bacillus parathyposus A.*	*Bacillus coli.*	*Bacillus paratyphosus B.*	*Bacillus paratyphosus A.*	*Bacillus coli.*	*Bacillus paratyphosus B.*	*Bacillus paratyphosus A.*
Days.										
157	3.5	4.3	2.2	1.5	4.3	4.5	2.4	8.7	5.0	3.5
186	6.0	5.8	4.4	1.5	9.0	3.0	2.5	10.0	6.6	2.0
216	5.0	4.6	3.5	-------	5.0	6.7	-------	9.3	5.0	-------
246	4.5	4.5	5.0	-------	7.5	7.0	-------	10.0	6.6	-------

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CERTAIN FACTORS SUPPOSED TO INFLUENCE THE RESULTS OF THE TREATMENT OF LEPROSY[1]

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INTRODUCTION

There are those who claim that the results of the treatment of leprosy are influenced largely by certain factors, as age, sex, civil status, nutrition, duration of leprosy at the time of admission of the cases, and type of leprotic lesions. As far as the writer is aware, no systematic investigation has yet been conducted for the verification of these claims, except that of Wade[2] in 1923, who based his observations on the clinical improvement of the cases then being treated by several clinic physicians in Culion. He himself was conscious of the fact that the personal equation of the individual physicians affected the results of treatment as reported by them. This is probably so, because of the lack of a standard measurement of clinical improvement.

BASIS UPON WHICH THE RESULTS OF TREATMENT WERE JUDGED

In order to avoid the objections to the use of clinical improvement as the basis for judging the results of the treatment, it is necessary to adopt some other kind of standard measurement of improvement. There is probably no better one, from the points of view of uniformity and of practicability, than the proportion of cases that have been paroled as a result of the treatment.

In the Philippines only the bacteriologically positive cases are by law required to be segregated. In order to determine whether a case is positive or not, smears are taken from the skin and the nasal mucosa, and none from the lymph nodes and nerves. When a case has become improved to such an extent that he no longer shows *M. lepræ* in smears taken from the skin and nasal mucosa, he is considered to be in the period of quiescence, and after one year of further observation (with regular periodic examination), provided that he has never subsequently been found positive bacteriologically, he is discharged from segregation and is placed under parole as an arrested case. For the purpose of this paper, the details regarding the parole system need not be gone into, but it suffices to say that the result of the treatment can best be judged by the proportion of paroled cases in each of the different groups studied, without taking into consideration the permanency of the apparent cure obtained from the treatment.

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[1] Published with the approval of the Director of Health.

[2] Wade, H. W., Journ. Philip. Is. Med. Assoc. 3 No. 5 (1923).

MATERIAL FOR STUDY

For the purpose of ascertaining how much, if at all, each of the factors mentioned above affects the results of treatment, the records of the patients admitted to the Eversley Childs Treatment Station from 1929 to 1933, inclusive, were reviewed. Excluding readmissions (relapsed paroled cases, returned absconders, and those retransferred from Culion and other stations), there were 1,235 new admissions during that period. Of these, 788 either were sent to the Culion Leper Colony, had died, or had absconded, leaving only 477 cases who were treated in this station up to May, 1935, or until paroled. These patients, it may be mentioned in passing, were treated almost entirely with *Hydnocarpus wightiana* oil, or its ethyl esters, either iodized or creosoted. Only very few were, for some time, placed under special treatments in experiments with new medicines. These 447 patients constitute the material for this study.

CLASSIFICATION OF CASES AND ITS RELATION TO THE RESULT OF TREATMENT

According to the classification of leprosy proposed by the Leonard Wood Memorial Conference on Leprosy held in Manila in 1931, there are two main types; namely, the neural (N) and the cutaneous (C). In addition the following subtypes of the above main types, indicating the degree of severity, were recognized:

Neural.	Cutaneous.
N-1. Slight neural.	C-1. Slight cutaneous.
N-2. Moderately advanced neural.	C-2. Moderately advanced cutaneous.
N-3. Advanced neural.	C-3. Advanced cutaneous.

The report of this conference further states: "In all cutaneous types there may be varying degrees of neural involvement and such cases should be recorded to indicate the degree of this involvement; as for example, C–2, N–1." However, in this paper only the cutaneous lesions are considered; the concomitant neural manifestations were disregarded.

TABLE 1.—*Relation of the types of leprosy (cutaneous only) to the results of treatment.*

Type.	Cases treated.	Cases paroled.	Per cent.
C–1	126	70	55.55
C–2	191	68	35.39
C–3	130	30	23.08

Table 1 shows that the amenability of leprosy to treatment is inversely proportional to the severity of the skin lesions. The reason for this is so obvious that it needs no further comment. However, it is also observed that some cases of the severer types have been paroled even earlier than some of the milder ones, which goes to show that, besides the severity of skin lesions, there must be other contributory factors that influence the results of the treatment.

RELATION OF THE DURATION OF LEPROSY ON ADMISSION TO THE RESULT OF TREATMENT

The duration of leprosy in each case was taken from the information given by the patient. (It is the period from the time the patient himself notices signs or symptoms of leprosy to the time of admission.) It is possible that all cases were infected in their early childhood as claimed by Manalang,[3] and that the disease has remained latent or in an atypical form until adult age or late in life as claimed by Chiyuto,[4] and these early manifestations were either not suspected of being those of leprosy or were entirely overlooked by the patient until frank lesions and symptoms developed. It is probable, therefore, that the real onset in most, or probably in all, of the cases had occurred much earlier, and that the duration was in reality much longer than that given by the patients. In view of the impossibility of determining the exact duration in each and every case, the duration given by the patients was considered more practical and sufficient for the purposes of this paper.

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[3] Manalang, C., Monthly Bull. Philip. Health Service 12 (1932) 363.

[4] Chiyuto, S., Monthly Bull. Bureau of Health, Manila (January, 1933) 5-48.

TABLE 2.—*Relation of the duration of leprosy on admission to the results of treatment.*

Duration.	Cases treated.	Cases paroled.	Per cent.
Less than 1 year	82	32	39.02
From 1 to 2 years	146	54	36.58
From 2 to 3 years	80	30	37.50
From 3 to 4 years	58	22	37.93
From 4 to 5 years	28	11	39.29
From 5 to 6 years	29	10	34.48
From 6 to 7 years	3	1	33.33
From 7 to 8 years	2	0	0.00
From 8 to 9 years	4	3	75.00
From 9 to 10 years	2	0	0.00
10 years and over	13	5	38.45

The proportion of paroled cases as shown in Table 2 is about the same in the different periods of duration given, except in those ranging from 6 to 10 years, where there were too few patients recorded. In other words, the results of the treatment is practically the same, irrespective of the duration of the disease as furnished by the patients. The explanation for this rather surprising finding is that the progress of the disease varies greatly in different individuals, and that while in some cases it may develop to an advanced stage within a year, in others it remains stationary or latent for a long time, so that there is no fixed relationship between duration and the skin subtypes.

THE RELATION OF AGE ON ADMISSION TO THE RESULTS OF TREATMENT

The relation of age to the results of treatment has been dealt with by many authorities. Wade[5] observed "that young people up to 20 years of age are increasingly amenable to treatment as they approach maturity, but from 20 to 30, during the period when sexual activity is at its height, the improvement rate falls off." He observed further that "the next decade is one of less activity and greater improvement for both sexes, but in the fifth decade, in which the males retain the improved rate, the females, who are disturbed by menopause, show a marked drop."

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[5] Loc. cit.

A similar observation was recorded by Rogers and Muir[6] who stated that "after the age of thirty most people have formed regular, steady habits, and on the whole the prognosis becomes more and more favourable after the age of forty." On the other hand, they claimed that "the vitality of youth, when it can be wisely curbed, is a powerful factor towards recovery."

More recently a controversy arose regarding the amenability to treatment of leprosy found in children. Rose[7] claims that "cases treated in early childhood, moreover, yield more readily to treatment than the adult," while Christian[8] claims that "In children leprosy treatment does not give such quick results as in adults, but when they reach adult age they improve and clear up rapidly under treatment."

TABLE 3.—*Relation of age on admission to the results of treatment.*

Age on admission.	Cases treated.	Cases paroled.	Per cent.
From 1 to 10 years	56	23	41.07
From 11 to 20 years	161	55	34.16
From 21 to 30 years	109	32	29.67
From 31 to 40 years	59	26	44.07
From 41 to 50 years	36	21	58.33
From 51 to 60 years	13	6	46.15
Over 60 years	13	5	38.46

Data regarding this point appear in Table 3. The results of the treatment in the above table, judged from the percentage of paroled cases, give a curve which goes down from the first to the third decade from where it goes up to the fifth, and thence goes down again. It appears then that the age on admission bears a certain definite relationship to the results of treatment.

The claim that the periods of puberty and childbirth have a bad effect on the prognosis of leprosy is apparently supported by these findings. Puberty occurs in the second decade, and the most productive childbearing period is in the third, and it is in these two decades that the results of treatment are poorest.

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[6] Rogers, L., and E. Muir, Leprosy. New York. Wm. Wood & Co. (1925).

[7] Rose, F. G., Leprosy Review 4 No. 4 (1934).

[8] Christian, E. B., Efficiency of institutional treatment of leprosy. Leprosy in India 6 No. 4 (October, 1934).

But it will be seen later in Table 6 that these two factors were not entirely responsible for the poor results in these two decades, for they did not even appear to be important factors in the treatment of these cases.

One reason why the results of treatment are poor in these two decades may be the fact that it is not until a patient passes the age of 30 that he begins to lead a regular life with steady habits, becomes serious about his treatment, and acquires a great determination to get well. It is also in the second and third decades that one is apt to indulge in the excesses and abuses of youth. After 50 the results of treatment go down steadily, probably because it is from this age that the recuperative powers of the body gradually decline.

Whether or not cases in early childhood yield more readily to treatment than adult cases cannot be determined with the available data in this study for the reason that there was only one case in early childhood, or below 5 years of age, admitted from 1929 to 1933. This case was paroled. If childhood as a whole is considered, those admitted in the first decade of life may be taken as cases of that period. The results obtained in this group are equal to the average of the percentages of the different age groups. It is better than the results obtained in the second and third decades and above the sixth, but poorer than those in the fourth, fifth, and sixth.

The results recorded in Table 3 suggest the possibility that there are comparatively few advanced cases in the decades showing good results and more of them in those with poor results. However, Table 4 shows that this is not the case.

TABLE 4.—*Proportion of the types of cutaneous lesions in the second, third, and fifth decades.*

Age on admission.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
From 11 to 20 years	50	31.06	66	40.99	45	27.95
From 21 to 30 years	26	23.85	46	42.21	37	33.94
From 41 to 50 years	8	22.22	19	52.78	9	25.00

In Table 4 the proportion of the types of skin lesions in the third decade where the result of treatment is poorest was compared with that of the fifth decade where the result is best, taking the second decade where the result is halfway between as a control. It can be seen that while it is true that the fifth decade had the smallest proportion of C-3 cases, it had likewise the lowest percentage of C–1 cases, which compensates for this apparent advantage. Hence, while it has already been shown that the advancement of skin lesions has some influence on the result of the treatment, it cannot be said that it is a deciding factor in determining the results of treatment in relation to age.

Further proof that age has an inherent influence independent of the advancement of the skin lesions is given in Table 5. Here it is shown that the percentage of paroles is highest in the fifth decade in all the cutaneous subtypes, compared with the two other decades under discussion.

TABLE 5.—*Percentage of paroled cases in each of the different types of skin lesions under the second, third, and fifth decades.*

Age group.	C–1.	Paroled.	Per cent.	C–2.	Paroled.	Per cent.	C–3.	Paroled.	Per cent.
From 11 to 20 years	50	23	46.00	66	22	33.33	45	10	22.22
From 21 to 30 years	26	15	57.69	46	10	21.74	37	7	18.81
From 41 to 50 years	8	6	75.00	19	10	52.63	9	5	55.55

RELATION OF SEX TO THE RESULTS OF TREATMENT

It has already been stated that the poor results of the treatment in the second and third decades of life may be due to the effects of puberty and childbirth. This will be better demonstrated by considering the two sexes separately.

The figures in Table 6 do not substantiate this contention. It may be possible that puberty was partly responsible for the percentage of paroles in the second decade, but it is not likely the main cause of it, for if this were the case, it should have affected more the females who manifest a depressed physiological state, some of whom actually become ill during puberty and at every menstruation which has no counterpart in the males. On the contrary, the percentage is much lower among the males than among the females in the second decade.

The low percentage of paroles in the third decade may be attributed to childbirth, but again this is not likely the case, for it would have affected the females only. As shown in Table 6, the percentage of paroles is much lower among the males than among the females. Hence, childbirth does not seem to have played an important rôle in determining the result of the treatment among these cases.

In view of the foregoing considerations, one is inclined to believe that some other factors, probably still undetermined, were responsible for these poor results of treatment in the two decades under consideration. Wade[9] says that these decades are the period when sexual activity is at its height, and he seems to attribute the poor results of treatment at this stage of life to this fact. At any rate, contrary to what is commonly claimed, puberty and childbirth do not seem to be important factors in the treatment, at least among these cases.

Wade observed that the improvement rates of different age groups and those for the different duration groups, plotted separately, will show that the females have for the most part a higher improvement rate than the males. In the fifth decade the females, who are disturbed by the menopause, show a marked drop, while the males show a good rate of improvement.

TABLE 6.—*Age and sex distribution of cases treated and paroled.*

Age group.	Males.			Females.		
	Treated.	Paroled.	Per cent.	Treated.	Paroled.	Per cent.
From 1 to 10 years	32	13	40.63	24	10	41.66
From 11 to 20 years	84	27	32.14	77	28	36.36
From 21 to 30 years	74	19	25.68	35	13	37.14
From 31 to 40 years	45	16	35.55	14	10	71.43
From 41 to 50 years	23	15	65.22	13	6	46.16
From 51 to 60 years	5	0	0.00	8	6	75.00
Over 61 years	11	4	36.36	2	1	50.00
Total	274	94	34.31	173	74	42.77

Table 6 apparently supports the observation of Wade based on the clinical improvement of cases under treatment. In all the different age groups (except the fifth decade) the females have a higher percentage of paroled cases than the males.

Are the female cases more amenable to treatment simply because of their sex, or is it because there are more of the less-advanced cases among them, or is leprosy more apt to develop in the female sex in those periods of life found to be favorable to treatment?

It appears in Table 7 that there were actually less of the advanced cases among females than among males. However, the difference is not marked enough to influence the difference in the proportion of paroled cases in the two sexes.

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[9] Journ. Philip. Is. Med. Assoc. 3 No. 5 (1923).

TABLE 7.—*Proportion of the types of skin lesions in males and females.*

Sex.	Total.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
Males	274	78	28.47	111	40.51	85	31.02
Females	173	50	28.90	76	43.93	47	27.17

On the other hand, the favorable influence of age does not seem to contribute anything towards the good results obtained in the females (see Table 8).

TABLE 8.—*Proportion of the different age groups in males and females.*

Age group.	Males.	Per cent.	Females.	Per cent.
From 1 to 10 years	32	11.68	24	13.87
From 11 to 20 years	84	30.65	77	44.51
From 21 to 30 years	74	27.00	35	20.23
From 31 to 40 years	45	16.42	14	7.69
From 41 to 50 years	23	8.39	13	7.01
From 51 to 60 years	5	1.83	8	4.62
Over 61 years	11	4.01	2	2.31

It was found in Table 3 that the first, fourth, fifth, and sixth decades gave better results than the second, and third, and beyond the sixth decades. In Table 8, if the first, fourth, fifth, and sixth decades are put together, it will be found that the males had 38.32 per cent of all their cases under these more-favorable age groups, while the females had only 33.09 per cent in these groups. Therefore, it may be said that age alone was not responsible for the favorable response to the treatment obtained among the females; on the contrary, this fact apparently placed the females at a disadvantage.

From the foregoing considerations it seems probable that sex per se has an influence on treatment independent of the other factors that have already been considered. The favorable results among the female lepers may be explained, in part, by the fact that the females are, as a rule, better patients, comply more strictly with instructions, are more serious in their treatments, and are less addicted to abuses than the males. Apparently these traits of the females more than offset the detrimental effects of childbirth and menopause.

RELATION OF THE CIVIL STATUS TO THE RESULTS OF TREATMENT

It was found in this investigation that those who were widowed showed better results under the treatment than the unmarried and married patients.

TABLE 9.—*Relation of civil status to the result of treatment.*

Civil status.	Cases treated.	Cases paroled.	Per cent.
Children [a]	93	34	36.56
Single	164	60	36.88
Married	166	59	36.58
Widowed	24	15	62.50

[a] Children up to 18 years old. It was thought proper to separate them in order not to influence the unmarried cases with whatever effect they may have.

In Table 9 the children, the unmarried, and the married cases show about the same results, while the widowed cases have a higher percentage of paroles. This may be partly due to the small percentage of advanced cases among the widowed, as is shown in Table 10.

TABLE 10.—*Comparison of the proportion of the types of skin lesions in the widowed cases with that of the entire group of patients.*

Group.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
Entire	126	27.88	191	42.70	130	29.42
Widowed	8	33.34	11	45.83	5	20.83

There were higher percentages of C–1 and C–2 cases, and a lower percentage of C–3 cases in the widowed patients than in the rest of the group treated.

Another contributory factor found to favor the effect of treatment in the widowed group is the fact that 66.67 per cent of the widowed cases (see Table 11) were in the fourth, fifth, and sixth decades, which were found in Table 3 to have high percentages of paroled cases.

TABLE 11.—*Comparison of the proportion of the different age groups in the widowed cases with that of the entire group of patients.*

Age group.	Cases treated.	Per cent.	Widowed cases.	Per cent.
From 1 to 10 years	56	12.51	0	0.00
From 11 to 20 years	161	36.03	1	4.16
From 21 to 30 years	109	24.39	4	16.67
From 31 to 40 years	59	13.20	4	16.67
From 41 to 50 years	36	8.06	6	25.00
From 51 to 60 years	13	2.91	6	25.00
Over 61 years	13	2.91	3	12.50

There were also fourteen females among the twenty-four widowed patients, or 58.33 per cent, and since females have a higher percentage of paroled cases than the males, this fact may also contribute to the good results found in the widowed cases.

The conclusion, therefore, is that the widowed cases herein studied showed favorable results under the treatment, because of the facts (*a*) that they were generally of mature age, (*b*) that there were more females than males among them, and (*c*) that they had a greater proportion of the slightly and moderately advanced cases and less of the advanced cases than the other groups of patients.

However, the widowed patients constituted only 5.37 per cent of the entire group, so that civil status did not seem to play an important rôle in influencing the results of the treatment of the whole group.

RELATION OF ROBUSTNESS TO THE RESULTS OF TREATMENT

For the purposes of this investigation, the state of nutrition was not determined on the basis of the height-weight ratio, but on the degree of robustness judged solely by inspection. The cases were classified into three groups: (*a*) The thin or undernourished, (*b*) the normal or well-nourished, and (*c*) the obese or over-nourished. When some difficulty was experienced in deciding whether a patient was thin or obese, the case was classified as normal or well-nourished.

TABLE 12.—*Relation of robustness to the result of treatment.*

Degree of nutrition.	Cases treated.	Cases paroled.	Per cent.
Thin	71	33	46.48
Normal	348	129	37.07
Obese	28	6	21.43

Table 12 shows that there were too few of the obese and thin patients to warrant definite conclusions. However, the difference in the results obtained in the different degrees of robustness is so striking that it cannot escape attention. The results of treatment may be considered, in view of these findings, to have a definite relation to the degree of nutrition. Contrary to what was expected, the obese showed the poorest results, while the thin cases gave the best. These findings are in agreement, however, with the frequent observation in this station that when a patient gains weight rapidly, his leprosy becomes either stationary or worse, even if he had been improving previously. The thin persons are generally observed to fare well under the treatment, provided their thinness is not due to complicating diseases.

To eliminate the possibility that the favorable effects shown among the thin individuals may be due to the preponderance of less-advanced cases among them, Table 13 was prepared.

TABLE 13.—*Proportion of the subtypes of skin lesions in the three different degrees of nutrition.*

Degree of nutrition.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
Thin	41	58.30	21	29.86	9	11.84
Normal	71	20.40	160	46.00	117	33.60
Obese	14	50.00	10	35.71	4	14.29

Table 13 shows that the proportion of less-advanced and well-advanced cases was about the same in the thin as in the obese groups, and for this reason the proportion of the different types of skin lesions may have had nothing to do with the result of the treatment found in relation to the degree of nutrition.

There were twenty-five cases, or 35.21 per cent, under the age groups found favorable to treatment in Table 3 among the thin cases compared with eleven cases, or 39.28 per cent, in the obese. Since these figures are practically the same, it may also be inferred that the favorable influence of age did not affect the results obtained under the consideration of nutrition.

There were twenty-nine females, or 40.57 per cent, among the thin, and nine females, or 32.14 per cent, among the obese. This slight advantage in favor of the thin patients alone cannot explain the difference in the percentage of paroled cases observed between the two groups.

Although the data here presented cannot be considered conclusive, it appears that the excess of fat in the body is an unfavorable element in the treatment of leprosy.

SUMMARY AND CONCLUSIONS

1. The effect of certain factors supposed to influence the results of treatment has been studied.

2. The severity of skin lesions was found inversely proportional to the percentage of paroled cases.

3. The duration of the disease was found to have apparently no relation to the results of treatment.

4. The age on admission was found to have a definite relation to the results of the treatment, in that the first, fourth, fifth, and sixth decades gave higher percentages of paroled cases than the other decades. The results, if plotted with age, gave a curve that goes down from the first to the third as the lowest point, gradually rising to the fifth decade as the highest point from which it goes down again.

5. The results of the treatment were found to be apparently better among the females than among the males, except in the fifth decade, probably due to the menopause which disturbs the physiological life of the females.

6. Contrary to what is commonly claimed, puberty and childbirth did not seem to be important factors in the treatment among these cases.

7. The results of treatment were found to be good among the widowed patients, but this is due to the fact that they are generally of mature age and, in the groups studied, there were more females and more of the less-advanced cases than among the unmarried and married cases.

8. The degree of nutrition was found to have a definite relation to the results of treatment. The results are inversely proportional to the degree of obesity of the patients. It appears that excess fat in the body has an unfavorable effect on the treatment of leprosy.

THE LETHAL EFFECT OF HOMOZYGOUS PURPLE AND EYELESS GENES IN DROSOPHILA

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INTRODUCTION

In both plants and animals there are genetic factors which cause not only certain morphological changes, but also the nondevelopment or nonfunctioning of certain vital organs, thus causing the death of individuals affected. These are known as "lethal factors." These factors may cause an early or late death of the organism affected, depending upon the nature of the effect. Thus Castle and Little's (5) homozygous yellow mouse dies in the early embryonic stage, while Detlefsen (8) reported a case of a lethal factor, also in the mouse, which allows the individuals affected to live only for a few days after birth.

In all cases of zygotic lethal factors thus far reported, the death of an organism has been found to be due to a single gene. This gene causes the death of the individual only when it is in a homozygous condition. When the individual is heterozygous, the effect of the gene is not fatal. This is true whether the lethal factor is dominant or recessive. Examples of dominant factors which are lethal when homozygous are the factors for the yellow mouse of Castle and Little, (5) for dominant spotting in the mouse of Little, (12) for star eye, streak thorax pattern, and confluent veins in the *Drosophila* of Bridges as reported by Bridges and Morgan, (2) and for beaded wing in the *Drosophila* of Morgan as reported by Bridges and Morgan. (3) Examples of recessive factors that are lethal when homozygous are the factors for abortive gametes in the velvet bean of Belling, (1) for the albino corn of Jones, (11) for the truncate wing in the *Drosophila* of Morgan, (14) and for the "stickiness," or extreme softening of the bones, in the domestic fowl of Byerly and Jull. (4)

Lethal factors may be found in the sex chromosome and are known as sex-linked lethals, or they may be found in the autosomes and are known as autosomal lethals. In *Drosophila* the sex-linked lethals are numbered l-I_1, l-I_2, l-I_3, etc., while the autosomal lethals are numbered l-II_a, l-II_b, l-II_c, etc., for the second chromosome, and l-III_a, l-III_b, l-III_c, etc., for the third chromosome. Sex-linked lethals are often the cause of the disturbance of the sex ratio in animals, as shown by the works of Rawls,(18) Morgan,(15) and Stark(19) in *Drosophila.* Autosomal lethals on the other hand affect both sexes equally and, therefore, do not cause any disturbance in the sex ratio. They, however, cause a deviation in the expected Mendelian ratios. Cases of autosomal lethals are illustrated by the work of Little(13) in the mouse, Jones(11) in the cat, Dunn(9) in fowls, Bridges and Morgan(2, 3) in *Drosophila,* Jones(11) in corn, and Belling(1) in the velvet bean.

Müller(17) reported cases of "balanced lethals" in *Drosophila* in which two linked lethal factors may be present and yet may not cause the death of the animal. This is due to the fact that neither is found in homozygous condition.

In this paper a new case in *Drosophila* is reported, in which two autosomal recessive factors that are found in different chromosomes act as lethal factors when brought together in homozygous condition, but are nonlethal when present alone. These factors are *eyeless,* a fourth chromosome mutation, which is recessive to eyed condition; and *purple eye,* a second chromosome mutation, which is recessive to red eye.

The author is indebted to Mr. Juan B. Ortega and Mr. Jose V. Yap Chiongco for helping him make these experiments.

MATERIALS AND METHODS

Two kinds of pure stock flies were used in these experiments. These were eyeless and purple, which were both obtained as mutations from the Bandless Manila Wild flies. The eyeless mutant was found June 22, 1926, and since then had been breeding true. Eyeless flies possess small heads due to the total or partial elimination of the compound eyes. Likewise, the ocelli are totally absent. Whenever a portion of the compound eyes is present, the color is red, showing that the eyeless mutant is a carrier of the red color factor. This is further substantiated in our cross between eyeless and purple stock which always results in the production of red-eyed offspring. Genetic tests of eyeless by Clemente(6) show that it behaves as a simple Mendelian recessive to eyed condition. According to Morgan, Sturtevant, Müller, and Bridges(16) this is a mutation of the fourth chromosome.

The purple-eyed mutation was found August 26, 1926, and until now is breeding true. This mutation affects the eye color, the shade of which changes with age. It is lighter in young flies and darker in old ones. The true purple shade develops when the adult flies are about a day or two old. Genetic tests with the wild flies show that purple behaves as a simple Mendelian recessive to its allelomorph red eye. According to Bridges and Morgan(2) this is a mutation of the second chromosome.

By a comparative study of their duration of life Clemente(7) has shown that eyeless and purple-eyed flies are practically the same in viability. Eyeless flies, however, are not as active as purple flies, due perhaps to the absence of eyes.

The food consisted of a well-stirred sliced ripe banana sprinkled with powdered yeast foam tablets. The breeding containers used were 8-drachm homœopathic vials for test matings and 120-cc bottles for stock cultures. All cultures were kept in a Frigidaire at a more or less constant temperature of 25° C.

Numerous types of matings were made, but special emphasis was given to those matings which would help prove that the flies that are homozygous for both purple and eyeless do not exist at all. In most cases reciprocal matings were made in order to obtain better results.

EXPERIMENTAL RESULTS AND DISCUSSIONS

CROSSING OF EYELESS TO PURPLE

About 10 virgin eyeless females were mated to 10 purple-eyed males. This mating produced 118 red-eyed F_1 offspring of which 53 were males and 65 were females (Table 1). A reciprocal mating was made in which the females were purple and the males eyeless. This gave 833 red-eyed F_1 offspring of which 429 were males and 404 were females. The total for the two reciprocal crosses was 951 flies of which 482 were males and 469 were females.

TABLE 1.—*F_1 offspring obtained by mating eyeless × purple.*

Type of mating.	Red-eyed.		Total.
	Males.	Females.	
Eyeless female × purple-eyed male	53	65	118
Purple-eyed female × eyeless male	429	404	833
Total	482	469	951

The results obtained in the above matings were to be expected if it is assumed that the eyeless parent, in addition to carrying the recessive eyeless factor (ee), also carries the dominant red-eyed factor (PP) and is, therefore, of the genotype (PPee). The purple parent, on the other hand, in addition to carrying the recessive purple factor (pp) also carries the dominant factor eyed (EE) and, therefore, is of the genotype (ppEE). The F_1 offspring resulting from the above matings would, therefore, be all red-eyed of the genotype (PpEe).

TABLE 2.—*F_2 offspring obtained by mating the F_1 together.*

Source of F_1.	Red-eyed.			Purple-eyed.			Eyeless.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
From eyeless females × purple-eyed male	451	435	886	157	150	307	107	136	243
From purple-eyed females × eyeless male	484	405	889	161	222	383	175	191	366
Total	935	840	1,775	318	372	690	282	327	609

MASS MATING OF THE F_1 TO OBTAIN F_2

In order to obtain the different F_2 phenotypes and their ratio, the F_1 of the two reciprocal crosses were mated together and the offspring were examined as to sex and eye characteristics. There were obtained in the F_2 three phenotypes: *red-eyed, purple-eyed,* and *eyeless* (Table 2). Theoretically, there should be eyeless carrying red and eyeless carrying purple, but due to the absence of eyes in both of them, they all appear together as eyeless. The F_2 results would, therefore, give a modified Mendelian dihybrid phenotypic ratio of 9 red-eyed : 3 purple-eyed : 4 eyeless, if they were all equally viable. The three phenotypes should theoretically contain the following genotypes:

9 Red-eyed	:	3 Purple-eyed	:	4 Eyeless	
1 PPEE		1 ppEE		1 PPee	1 ppee
2 PpEE		2 ppEe		2 Ppee	1 pe
2 PPEe		3 pE		3 Pe	
4 PpEe					
9 PE					

The above ratio of 9: 3: 4 was not, however, realized in the F_2 of both reciprocal crosses, there being too few eyeless in proportion to the red-eyed and purple-eyed phenotypes. In a total of 3,074 F_2 flies, 1,775 were red-eyed, 690 were purple-eyed, and only 609 were eyeless. If the 9 : 3 : 4 ratio be correct, there should be, theoretically, 1,729 red-eyed, 576 purple-eyed, and 768 eyeless flies (Table 3). The actual result obtained deviates from the theoretical expectation by an excess of 45 flies in the case of red-eyed, and 113 flies in the case of the purple-eyed, while the eyeless is short 159 flies. The great reduction in the number of eyeless flies in the F_2 is certainly significant and this may mean one or the other of the following possibilities: It may mean that the eyeless are not as highly viable as the red-eyed and purple-eyed flies or that a certain genotype of the eyeless flies such as those which are homozygous for both eyeless and purple (ppee) is lethal. The first assumption can be dismissed because it has been shown by Clemente (6, 7) that the viability of both eyeless and purple is about the same and why is there such a great discrepancy in the eyeless as compared with the purple-eyed when the eyeless in this specific instance should be the more numerous? There remains the possibility that a certain phenotype of the eyeless, such as the homozygous purple eyeless (ppee), is lethal, in order to explain their great deficiency in number among the F_2 offspring. If this assumption be correct, the F_2 phenotypic ratio would be 9 red-eyed : 3 purple-eyed : 3 eyeless. A comparison of the actual number obtained of the different F_2 phenotypes and the theoretical number calculated based on the 9 : 3 : 3 ratio seems to bear out this explanation (Table 4).

TABLE 3.—*Comparison of the actual and theoretical number of F_2 offspring based on the 9: 3: 4 ratio.*

F_2 phenotypes.	Actual number.	Theoretical number.	Deviation.
Red-eyed	1,775	1,729⅛	+ 45⅞
Purple-eyed	690	576⅜	+113⅝
Eyeless	609	768½	—159½
Total	3,074	3,074	0

TABLE 4.—*Comparison of the actual and theoretical number of F_2 offspring based on the 9:3:3 ratio.*

F_2 phenotypes.	Actual number.	Theoretical number.	Deviation.
Red-eyed	1,775	1,729$\frac{1}{8}$	+ 45$\frac{7}{8}$
Purple-eyed	690	576$\frac{3}{8}$	+113$\frac{5}{8}$
Eyeless	609	576$\frac{3}{8}$	+ 32$\frac{5}{8}$
Total	3,074	2,881$\frac{7}{8}$	—192$\frac{1}{8}$

MASS MATING OF THE F_2 PURPLE-EYED

The mass mating of purple F_2 is a crucial test in the determination as to whether the individuals that are homozygous for both purple and eyeless (ppee) are lethal or not. If in this cross eyeless individuals are produced, it will be positively proven that they are nonlethal. If on the other hand, no eyeless are produced, the purple eyeless (ppee) must be regarded as lethal.

TABLE 5.—*Results of mass mating of the F_2 purple-eyed.*

Source of F_2 purple-eyed.	Purple-eyed.			Eyeless.		
	Males.	Females.	Total.	Males.	Females.	Total.
From eyeless female × purple male	241	235	476	0	0	0
From purple female × eyeless male	232	259	491	0	0	0
Total	473	494	967	0	0	0

Theoretically, there are two genotypes (ppEE) and (ppEe) among the F_2 purple in the proportion of one of the former to two of the latter. A mass mating of these at random should produce purple-eyed of the genotypes (ppEE and ppEe) and purple-eyeless of the genotype (ppee). By using the formula of Jennings(10) in such random mating where (s) stands for 2 (ppEe) and (r) for 1 (ppEE), the relative proportion of the different genotypes in the offspring would be as follows:

$$\frac{(s + 2r)^2 \text{ ppEE} + s^2 \text{ ppee} + 2s\ (s + 2r) \text{ ppEe}}{4(s + r)^2} =$$

$$\frac{16 \text{ ppEE} + 4 \text{ ppee} + 16 \text{ ppEe}}{36} =$$

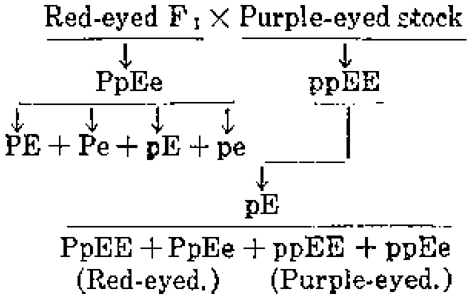
$$\frac{4 \text{ ppEE} + 1 \text{ ppee} + 4 \text{ ppEe}}{9}.$$

Table 5 shows the result of this cross. In a total of 967 flies, of which 473 were males and 494 were females, not a single eyeless fly was produced. If the eyeless purple were nonlethal, there should be 1 purple eyeless to every 8 purple-eyed flies produced in this mating. It means that at least 120 purple eyeless were expected to the 967 purple-eyed flies that were produced, but as previously stated, not a single purple eyeless was found. This result proves beyond doubt that the individuals that are homozygous for both purple and eyeless (ppee) are lethal or nonviable.

BACK-CROSSING OF THE F_1 TO PURPLE STOCK

This mating was done in order to find out whether purple-eyed of the genotype (ppEe) is lethal or viable. A knowledge of the viability or nonviability of this genotype of purple-eyed is necessary because it may mean that the reason why no purple eyeless (ppee) was produced in the mass mating of the F_2 purple-eyed was that (ppEe) are themselves nonviable. If in this mating it can be proven that they are viable, the failure of the purple eyeless (ppee) to appear in the mass mating of the F_2 purple-eyed is due to the lethal effect of the combined genes of purple and eyeless and not to other causes.

This cross should give, theoretically, red-eyed and purple-eyed in equal numbers and each phenotype should consist of two genotypes as follows:



The results of this cross are shown in Table 6. In a total of 192 flies produced, 92 were red-eyed and 100 were purple-eyed or a ratio that is approximately 1 : 1. This is exactly what would be expected if the two genotypes of the purple-eyed (ppEE and ppEe) are as equally viable as the two genotypes of the red-eyed (PpEE and PpEe). If the purple-eyed of the genotype (ppEe) were lethal there would be produced in this mating individuals in the proportion of 2 red-eyed to 1 purple-eyed. But this was not found to be the case. This cross, therefore, proves conclusively that purple of the genotype (ppEe) is viable and that the failure of the purple eyeless (ppee), to appear in the mass mating of the F_2 purple is due to the lethal effect of the combined genes of purple and eyeless and not due to other causes.

TABLE 6.—*Results obtained in a back-cross of the F_1 to purple stock.*

Source of F_1.	Red.			Purple.		
	Females.	Males.	Total.	Females.	Males.	Total.
From eyeless female × purple-eyed male	38	31	69	43	31	74
From purple female × eyeless male			23			26
Total	38	31	92	43	31	100

It might be stated in this connection that the proportion of the purple-eyed to the red-eyed and eyeless in the F_2 is also strong evidence in support of the theory that the purple-eyed of the genotype (ppEe) is viable. If they were lethal, the number of purpled-eyed F_2 would be reduced by two-thirds and there would be only 1 purple-eyed to every 9 red-eyed flies. The actual numbers obtained, as can be seen in Table 2, is approximately 1 purple-eyed to every 3 red-eyed flies, thus precluding all doubts as to the viability of purple-eyed of the genotype (ppEe).

BACK-CROSSING OF THE F_1 TO EYELESS STOCK

The next question which needs to be solved is whether or not the eyeless of the genotypes (Ppee) is lethal. This cross is necessary in order to find out whether the great reduction in the number of eyeless in the F_2 is due to the death not only of the purple eyeless (ppee) but also of the eyeless of the genotype (Ppee). This was done by back-crossing the F_1 (PpEe) red-eyed to the eyeless stock which carries the red gene in homozygous condition (PPee). This mating should give, theoretically, red-eyed and eyeless in equal numbers with each phenotype representing two genotypes as follows:

Red-eyed F_1 × Eyeless (Red)
↓ ↓
PpEe PPee
↓ ↓ ↓ ↓
PE + pE + Pe + pe
↓
Pe
PPEe + PpEe + PPee + Ppee
(Red-eyed.) (Eyeless.)

As can be seen in Table 7, the two expected phenotypes, red-eyed and eyeless, were realized in about equal numbers, there being 47 red-eyed and 41 eyeless in a total of 88 flies. This equality in the numbers of red-eyed and eyeless flies is conclusive proof that the two genotypes of the red-eyed (PPEe and PpEe) are as viable as the two genotypes of the eyeless (PPee and Ppee). If the eyeless of the genotype (Ppee) were lethal, the result in this mating would be in the proportion of 2 red-eyed to 1 eyeless instead of 1 to 1 as was obtained.

TABLE 7.—*Results obtained in a back-cross of the F_1 to eyeless stock.*

Source of F_1.	Red-eyed.			Eyeless.		
	Females.	Males.	Total.	Females.	Males.	Total.
From eyeless female × purple-eyed male	11	17	28	14	15	29
From purple female × eyeless male....	--------	--------	19	--------	--------	12
Total........................	11	17	47	14	15	41

The proportion of the eyeless to the red-eyed in the F_2 is strong evidence in support of the theory that the eyeless of the genotype (Ppee) is viable. If this genotype of the eyeless were nonviable, the already reduced number of F_2 eyeless due to the death of the homozygous purple eyeless (ppee) would further be reduced to such an extent that there would be only 1 eyeless to every 9 red-eyed flies. The actual result obtained in the F_2, as can be seen in Table 2, does not seem to bear this out. There are on the average 3 red-eyed flies to 1 eyeless fly, which helps to prove conclusively that the eyeless of the genotypes (Ppee) is nonlethal.

SUMMARY AND CONCLUSIONS

It can be concluded from the above experiments that the flies which are homozygous for both purple and eyeless (ppee) die as shown by their failure to appear in all crosses. This is especially shown in the mating together of the F_1 to produce F_2 and in the mass mating of the F_2 purple.

The results obtained in the F_2 which gave an approximate ratio of 9 red-eyed : 3 purple-eyed : 3 eyeless instead of the theoretical 9 red-eyed : 3 purple-eyed : 4 eyeless, is strong evidence in support of the theory that the eyeless purple (ppee) is nonviable. If it were viable, there would have been more eyeless flies than purple-eyed in the proportion of 4 : 3.

The mass mating of F_2 purple failed to produce a single eyeless fly. Theoretically, one of every nine flies in this mating should be eyeless if the purple-eyeless (ppee) is nonlethal, inasmuch as two of every three F_2 purple-eyed flies are heterozygous for the eyed condition. The total absence of eyeless among hundreds of offspring by mass mating of F_2 purple is indisputable proof that the purple-eyeless combination is lethal.

It can also be concluded from these experiments that other combinations of eyeless and purple, such as purple-eyed of the genotype (ppEe) and red-eyeless of the genotype (Ppee), are viable or nonlethal. These were proven by back-crossing the F_1 which are double heterozygous (PpEe) to purple-eyed stock (ppEE) on one hand and to red-eyeless (PPee) on the other.

The fact that a 1 : 1 ratio of red-eyed to purple-eyed flies was obtained in a back-cross of F_1 red-eyed (PpEe) to purple-eyed (ppEE) is good proof that the purpled-eyed of the genotype (ppEe) is viable. If it were lethal there would have been produced in this cross a ratio of 2 red-eyed to 1 purple-eyed.

In a similar way the 1 : 1 ratio of red-eyed to eyeless flies obtained by back-crossing the F_1 red-eyed (PpEe) to red-eyeless stock (PPee) is a good indication that eyeless of the genotype (Ppee) is viable or nonlethal. If it were lethal the offspring resulting from this cross would have been in the proportion of 2 red-eyed to 1 eyeless.

These experiments present a new case of zygotic lethal factor in which, instead of a single gene in homozygous condition as responsible in the death of an organism as heretofore reported, two sets of independent genes in homozygous condition were found to be the cause of the lethal effect.

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THE CENTRAL NERVOUS, TRACHEAL, AND DIGESTIVE SYSTEMS OF A NYMPHOMYIID FLY[1]

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ONE PLATE AND FIVE TEXT FIGURES

In my previous paper (1935), on the external anatomy, I reported that the paired lateral organs just caudad of the compound eyes of *Nymphomyia alba* Tokunaga may be certain sensory organs related to the adaptive or larval ocelli, rather than to the primary adult ocelli, and, likewise, I touched on the arrangement of the abdominal ganglia. However, their details were not studied. Now I intend to discuss the whole structure of the central nervous system to complement my previous report. Moreover, after reëxamination of living material, as well as of sections, I can now elucidate the entire tracheal system of this fly in addition to confirming an earlier preliminary theory that the posterior pair is the true spiracle of the metathorax and that the anterior one is not a respiratory pore but a sensory pore. The true spiracle of the mesothorax is displaced far cephaloventrad, being located on the ventral corner of the postpronotal plate. Further and more-detailed data on the alimentary canal are also included.

In the study of the central nervous and digestive systems sections were mainly resorted to. Reconstructions were made from paraffin sections, especially for the investigation of the supra- and subœsophageal ganglia. For the study of the tracheal system living material was dissected in distilled water and the dismembered pieces were mounted in water. The material was preserved in a 4 per cent aqueous solution of formalin. This reagent does not rapidly penetrate into the tracheæ; hence, they remain filled with air, which makes them appear as dark or silvery lines under transmitted or reflected light. Soon after dissection of the living material both tracheæ and tracheoles show

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[1] Contribution from the entomological laboratory, Kyoto Imperial University, No. 47.

distinctly; but after a short stay in the formalin solution the tracheoles disappear and then the tracheæ become transparent, even in the main tracheal trunks, due to the absence of the tinged or thickened spiral threads, or tænidia, in this fly. The material for the section method was fixed in Carnoy's fluid, stained with eosin-alcohol in toto, cleared in cedar oil, and embedded in paraffin the melting point of which is about 56° to 58° C. The serial sections were cut 8 microns thick and stained again with Delafield's hæmatoxylin-eosin. The material stained in toto with methylene blue and eosin was also dissected in cedar oil, and the pieces dissected were mounted in the same oil for observation.

This study was undertaken under the direction of Prof. Hachiro Yuasa, to whom I express my deepest thanks. I also thank Prof. Dr. T. Esaki and Dr. H. J. Feuerborn for the gift of invaluable literature.

CENTRAL NERVOUS SYSTEM

The central nervous system of *Nymphomyia alba* consists of the following separate ganglia: Two cephalic, three thoracic, and eight abdominal (text fig. 1, *A*). The separate condition and the noncoalesced eight abdominal ganglia in the present fly are very rare among the higher pterygotan insects, especially in the adult stage. In the dipterous insects a similar ganglionic condition is known in the larvæ of many orthorrhaphous families—Tipulidæ, Culicidæ, Mycetophilidæ, Chironomidæ, Leptidæ, Asilidæ, Bibionidæ, Therevidæ, Xylophagidæ, and Dolichopodidæ—but in the adult stage of these insects, at least, two posterior ganglia, the seventh and the eighth, are fused with each other, forming a ganglionic center, showing at most seven abdominal ganglia. The abdominal nervous system, as a whole, is displaced more or less cephalad (Brandt, K. d'Herculais, Perfiljew, and Miall and Hammond). This coalescence and cephalization have an important significance related to the specialization in phylogenetic and systematic directions (Beier, Deegener, Imms, et al.). Thus, the isolated and noncephalized condition of eight abdominal ganglia in the present insect is unusual among dipterous imagines. It probably represents a comparatively primitive type of development of the nervous system itself, bearing a relation to the loose fusion of the neuromeres of each ganglion and the wide separation of paired connectives throughout the thoracic and abdominal regions. Although the two cephalic ganglia, supra- and subœsophageal, are closely united, forming a compact mass, as in other Diptera in general, the shape of the brain and relative position of various parts of cerebral lobes are highly characteristic and related to the specialization of the external structure of the head capsule itself. The nerves originating from the head ganglia are largely reduced, correlated with the extreme reduction of the trophic organs. The three thoracic ganglia are widely separated from each other, due to the elongation of the thorax, but normally arranged and not displaced from their primary segmental position.

Supraœsophageal and subœsophageal ganglia (text fig. 1, B and C).—The supraœsophageal ganglion is closely united with the subœsophageal one, is perforated by the œsophageal canal, and occupies almost the entire cavity of the head capsule. It is somewhat conical in general shape and is elongated along the longitudinal axis of the head; the optic lobes (*ol*) occupy the anterior pointed part of the conical brain and the paired lobes are closely applied to each other on the mesal side and not produced laterad, as is generally the case in other dipterous insects, which are provided with laterally projected paired optic lobes. Thus the optic nerves for the compound eyes (nerves between the periopticons and epiopticons) originate from the lateral side of the cephalic projections of the frontal lobes, (*fl*). Besides these modifications, the various elements constituting the supraœsophageal ganglion are very different topographically from those of the other dipterous insects.

The protocerebrum is very large, occupying more than the dorsal half of the supraœsophageal ganglion, and consists of small mushroom bodies, a large protocerebral bridge, a large central body, and several very large cerebral lobes.

The mushroom bodies (*mb*) are very simple and small, as in other nematocerous insects in general (Hanström), situated on the dorsocentral region of the brain, and two lateral bodies are widely separated from those of the other side by a large central body (*cb*) and protocerebral bridge (*pcb*). The two mushroom bodies of each side are closely united with each other, being actually fused partially on the basal parts of their peduncles. The lateral mushroom body is larger than the mesal, being provided with a larger calyx and peduncles. The calyx (*cx*) is also small, elongated oval, not ringlike or cuplike, thus differing from the typical calyx. The peduncle (*pc*) is short and very simple, not

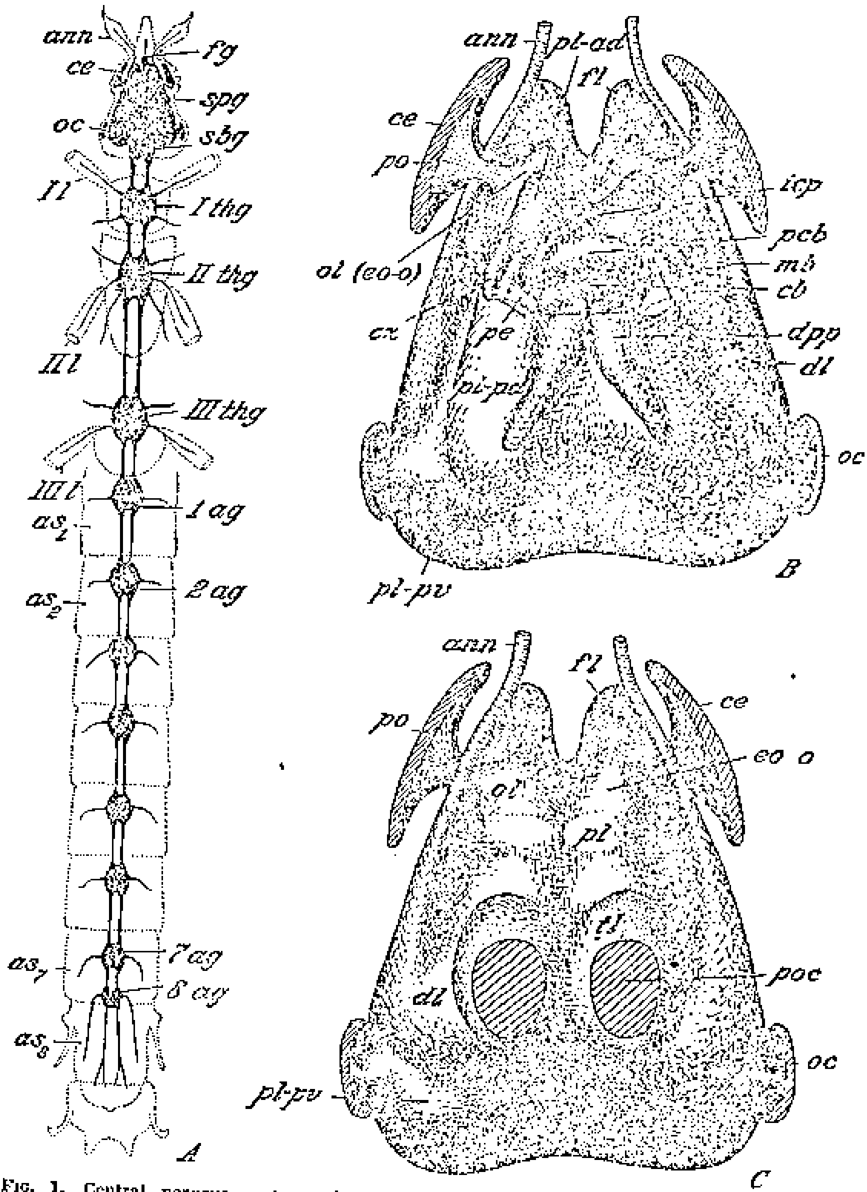

FIG. 1. Central nervous system of *Nymphomyia alba* Tokunaga. *A*, Arrangement of ganglia; *B* and *C*, dorsal and ventral aspects of supracesophageal ganglion, showing metameric structure of neurospongium (cortical layer of ganglionic cells represented by black parts); *ag*, abdominal ganglion; *ann*, antennary nerve; *as*, abdominal segment; *cb*, central body; *ce*, compound eye; *cx*, calix; *dl*, deutocerebral lobe; *dpp*, middorsal lobe; *eo*, epiopticon; *fg*, frontal ganglion; *fl*, frontal lobe; *icp*, intercerebral part; *l*, leg; *mb*, mushroom body; *o*, opticon; *oc*, ocellus; *ol*, optic lobe; *pcb*, protocerebral lobe; *pl-ad*, anterior dorsal lobe; *pl-pd*, posterior dorsal lobe; *pl-pv*, posterior ventral lobe of protocerebrum; *po*, periopticon; *poc*, paracesophageal connective; *sbg*, subœsophageal ganglion; *spg*, supracesophageal ganglion; *thg*, thoracic ganglion, *tl*, tritocerebral lobe.

forming a complex structure, which attains the maximum in complexity in the Lepidoptera.[2] The development of the glomeruli associated with the mushroom body is very poor in the present fly.

The protocerebral bridge (*pcb*) and central body (*cb*) are well developed, subequal in shape and size, horizontally arranged, the former bridge being located cephalad, the latter being displaced from the normal vertical arrangement.

In addition to the above characteristic structures, the protocerebrum may be divisible into several lobes; namely, the paired middorsal (*dpp*), the anterior dorsal (*pl-ad*), the posterior dorsal (*pl-pd*), the optic (*ol*), and the posterior ventral lobes (*pl-pv*). The middorsal lobes are elongated, paired, situated on the middorsal side of the protocerebrum; their cephalic parts are fused with each other and located under the central body. The anterior dorsal lobe (*pl-ad*) is bicornuate posteriorly, located cephalad of the protocerebral bridge or dorsad of the optic lobes. In certain insects that are provided with primary ocelli, the nerves for the ocelli originated from this lobe. The posterior dorsal lobe (*pl-pd*) is very large, slightly bilobate on the posterior part, and not provided with distinct nerve cords. The optic lobes (*ol*) are not projected laterad but cephalad, being closely united with each other and forming a distinct, cephalic, bilobate frontal lobe (*fl*) accompanying a thick peripheral layer of ganglionic cells and highly different in their arrangement from that in other insects.

Histologically, this part of the optic lobe consists of the opticon, or internal medulla, and the epiopticon, or external medulla. From the lateral side of each optic lobe the nerve for the compound eye arises and forms a thin layer of the periopticon, or ganglionic lamina (*Po*), closely along the inner side of the compound eye. The opticon of the Diptera is said to be composed of three layers (Cajal and Sanchéz), but in *N. alba* these layers are not distinct and form a solid medullary mass. The posterior ventral lobe (*pl-pv*) is very large, extends caudad, and reaches the occipital margin of the head capsule. The large lateral ocellus (*oc*) is directly connected with the lateral side of this lobe by a very short nerve.

The deutocerebrum is comparatively large, located under the posterior ventral lobe of the protocerebrum and consists of large, compact, paired masses of the antennary glomeruli (*dl*), a narrow median bridge which connects the two masses of the antennary glomeruli, and a common cortical layer of ganglionic cells. The nerve for the antenna (*ann*) originates from the laterocephalic part of the deutocerebral lobe; it extends cephalad along the lateral side of the neurospongium of the brain and under the optic nerve through the cortical layer of the protocerebrum and then freely to the antenna from the cephalic end of the frontal lobe (*fl*).

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[2] Bretschneider, F., Jen. Zeit. Naturw. (1921 and 1924) 57 and 60.

The tritocerebrum (*tl*) is composed of paired oval tritocerebral lobes and the common cortical layer. The former are partially fused with each other on the mesal side. The nerves arising from these lobes cannot be clearly distinguished.

The development of the sympathetic nervous system associated with the supraœsophageal ganglion is very obscure, being represented only by the frontal ganglion (*fg*) and its delicate connectives, which originate from the mesal side of the tritocerebral lobes. From the frontal ganglion a fine frontal nerve extends into the snoutlike projection of the head and a delicate recurrent nerve caudad along the dorsal side of the œsophageal pump. Other sympathetic ganglia and the accessory nerves have not been demonstrated in this fly.

The subœsophageal ganglion is somewhat elongated, comparatively large, closely associated with the supraœsophageal ganglion, and connected with the latter ganglion by the large but short paraœsophageal connectives (*poc*); the neuromeres of this ganglion are closely fused with each other forming a compact mass of neurospongium. The nerves that arise from this ganglion for the various appendages of the mouth parts are almost completely degenerated, being correlated with the extreme reduction of the external structures of the trophic organ as in the case of the sympathetic nervous system of the head.

Thoracic and abdominal ganglia (*text fig. 1, A*).—The three thoracic ganglia (*I–IIIthg*) are widely separated from each other due to the elongation of the thoracic structures as a whole. Their position is normal, each ganglion being situated on the middle of the sternal region of each thoracic segment to which it properly belongs. The first and third ganglia are each provided with two pairs of main nerves, which are chiefly extended into the legs and muscles related to the body wall. The second ganglion, besides these main nerves, is provided with a pair of the alary nerves.

The abdominal central nervous system consists of eight isolated ganglia, including the ultimate ganglionic center, which is thought to be formed by the fusion of three ganglia at least. This polyganglionic condition of the abdomen of *N. alba* is thought to represent the maximum number of the abdominal ganglia for the Diptera, in the imaginal stage.

From the phylogenetic point of view (Beier, Deegener, Imms, et al.), this polyganglionic condition does not indicate that *Nymphomyia* belongs to a group higher than the Nematocera nor that this genus ranks high among the nematocerous groups. The polyganglionic condition of the imagines sometimes results from the decentralization of the elements as they exist in the oligoganglionic condition of the larvæ in various higher brachycerous families; such as, the Stratiomyidæ, Syrphidæ, Tabanidæ, Conopidæ, and acalypterous Muscoidea (Künckel d'Herculais). In these cases, however, the nervous system as a whole is located more or less anteriorly and never retains eight abdominal ganglia, usually far less than eight. The arrangement of the abdominal ganglia of *N. alba*, excepting the ultimate ganglionic center (*8ag*), is quite normal, as in the thoracic region, each ganglion being situated on the anterior part of the sternal region of each segment. The ultimate ganglionic center alone has migrated slightly cephalad and is in the preceding, seventh, abdominal segment (*as7*), but this tendency is widely and normally known in many insects, including immature forms of various orders, and even among the primitive apterygotan insects.

Each abdominal ganglion from the first to the seventh is provided with a pair of main nerves, which are chiefly distributed on the abdominal muscles. The ultimate ganglionic center consists of three pairs of distinct neuromeres, at least, from each of which originates a pair of main nerves for the muscles of the segment and various genital appendages. The first pair of these nerves originates independently from the cephalic neuromeres, while the second and third pairs, arising from the middle and caudal neuromeres, are closely united with each other, forming one cord on each lateral side, and forked far distad. Throughout the thorax and abdomen the paired neuromeres of each ganglion are not closely united with each other, and consequently the paired connectives between the ganglia are widely separated; that is, the transversal fusion between the paired lateral halves of the longitudinal series of the neuromeres is not complete, differing from the higher dipterous insects. Other morphologic and histologic structures of the thoracic and abdominal nervous system, including the sympathetic nerves, are not so highly specialized from the other known cases to be mentioned.

TRACHEAL SYSTEM

In the most primitive condition twelve spiracles are present, being located on each of the thoracic and the anterior nine abdominal segments. This condition, however, is only known in the embryonic state of *Leptinotarsa*. In the postembryonic stages eleven pairs of spiracles, at most, are exceptionally present in the hyperpneustic insects, such as *Japyx* spp., which are provided with the prothoracic spiracles. Usually the number of spiracles is reduced to much less than eleven, especially in the higher Pterygota, the prothoracic spiracles being always atrophied in the adult condition, showing ten pairs in the holopneustic insects. Dipterous imagines show a great reduction in the number of abdominal spiracles, and sometimes the abdominal spiracles are completely or almost completely atrophied, as in *Deuterophlebia* (Edwards) and *Psychoda* (Kemper). This extreme reduction is found also in *N. alba*, in which all the abdominal spiracles are completely reduced.

The origin of the two thoracic spiracles of the pterygotan insects has been discussed by various authors, especially in the case of the Diptera. Many investigators (Feuerborn, Kemper, Lehmann, Palmen, Taylor, et al.) support the conclusion that the two paired thoracic spiracles of the adult insect properly belong to the meso- and metathoracic segments, respectively, and the prothoracic respiratory organs seen in the dipterous larvæ and pupæ, which are the secondary derivative, originally belonged to the mesothorax. If this theory of the thoracic spiracles is accepted, the unusual pronotal position of the first thoracic spiracles of the nymphomyiid fly is thought to be due to the cephaloventral displacement of the true mesothoracic spiracles.

In accordance with the extension of the tracheal branches, which are originally developed segmentally from the spiracular depressions, longitudinal and transversal anastomoses occurred between the tracheæ of the successive segments and the lateral halves. In the present case the development of the tracheal system is very low, exhibiting a vestigial condition. The longitudinal tracheal connection is represented only by the main dorsal trunk, which extends between the mesothoracic spiracle and the eighth vestigial abdominal spiracle. The double connection is shown only between the metathorax and the first abdominal segment, highly differing from the condition in *Simulium* and *Psychoda*, which show the double tracheal connection between the meso- and metathoracic spiracles. Although the tracheal system of *N. alba* is very simple, it is different from the primary simple type of the Apterygota by the presence of the anastomoses, both longitudinal and transverse; it belongs to the tertiary simple type derived from the secondary complex type (Weber, 1933).

The longitudinal connections of the tracheal branches typically form three tracheal trunks on either side; namely, the dorsal, lateral, and ventral trunks. Judging from the distribution of the tracheal branches, in *N. alba*, the dorsal trunk alone remains as the main trunk, extending from the mesothorax to the eighth abdominal segment; the lateral one is almost atrophied, exhibiting a short trachea between the metathorax and the first abdominal segment. The ventral trunk is completely wanting. The lateral pairs of the tracheal system are usually connected with each other by the dorsal and ventral commissures. Although the ventral commissures of the abdomen are wanting in both imaginal and immature forms of the dipterous insects, the other commissures, as a rule, are well developed segmentally (Kemper, Kuster, de Meijere, Taylor, et al.). However, in *N. alba* they are greatly reduced, and only the first dorsal commissure of the thorax remains to connect the lateral halves of the entire tracheal system.

SPIRACLES

Respiratory openings of *Nymphomyia* are represented only by the two pairs of minute thoracic spiracles, and those of the abdomen are too highly reduced to be detected externally.

Thoracic spiracles (text fig. 2, A and B, and text fig. 3, A).—The metathoracic spiracle (*IIIsp*) is found in the position normal for a dipterous insect, close to the base of the haltere, while the mesothoracic spiracle (*IIsp*) is displaced far cephaloventrad from the normal position, being situated on the ventral corner of the triangular lateral plate of the postpronotum, as shown in text fig. 3, *A*. In the position where the mesothoracic spiracle would be expected in the nematocerous Diptera in general there is a minute spiraclelike pore (*ps*) which is a porelike sensorium.

Both mesothoracic and metathoracic spiracles open directly on the thoracic wall without accompanying special accessory sclerites or peritremes. These two spiracles are almost alike in structure and size. The cover plate of the spiracular chamber, or spiracular plate, is very thin and almost hyaline, bluntly convex externally, circular in outline, and about 9 microns in diameter. In the mesothoracic spiracle the opening of the spiracle, or porta atrii, is in the center of the circular cover plate, while in the metathoracic spiracle the porta atrii is slightly eccentric. The spiracular chamber, or atrium, is almost spherical and its wall is smooth and hyaline without special spinous or setigerous structures. There is a slight constriction between the atrium and the common base of the tracheæ. At this constriction the tracheæ are closed out from the atrium by means of two small spiracular muscles (*sm*) and an accessory closing ring (*sr*).

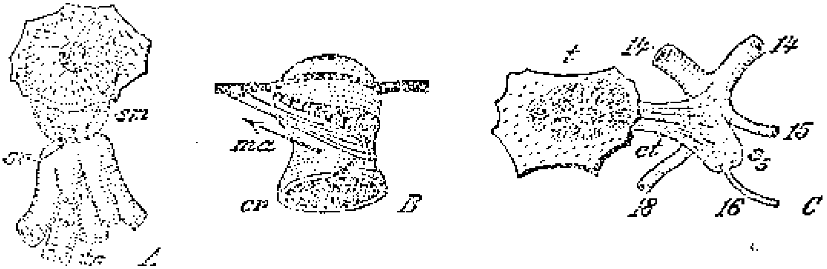

FIG. 2. Spiracles of *Nymphomyia alba* Tokunaga. *A*, metathoracic spiracle; *B*, diagrammatic structure of thoracic spiracle showing closing apparatus; *C*, vestigial spiracle of first abdominal segment; *cr*, direction of action of chitin ring; *ct*, ligamentous support; *ma*, direction of muscular action; *s*, spiracular chamber; *sm*, spiracular muscle; *sr*, closing spiracular chitin ring; *t*, paratergal tubercle; *tr*, trachea.

The mechanism of the closing apparatus is shown in text fig. 2, *B*. The free end of the spiracular ring applied at the constriction between the atrium and the tracheal base is pulled along the direction of *ma*-arrow by the contraction of the paired spiracular muscles; then the free end of the spiracular ring moves along the direction of *sr*-arrow, which is a part of a circular margin having its center at the hinge of the spiracular ring so as to close up the tracheal base from the atrium. The opening of the spiracle is due to the relaxation of the spiracular muscles and to the elasticity of the wall of the trachea and atrium, and not to the special antagonistic muscles.

Abdominal spiracles (*text fig. 2, C*).—The abdominal spiracles are highly reduced, their external openings being completely closed. These vestigial spiracles are found on the first eight abdominal segments. The first abdominal spiracle, however, is completely reduced and there is no trace of spiracular structures, but the similar condition of the tracheal convergence to that of the other segments shows that the first abdominal spiracle has been situated on the middle of the paratergal lobe. The other vestigial spiracles are all alike in structure and position, except the eighth abdominal spiracle, which is modified slightly. On the paratergal lobe just caudad of the paratergal tubercle five tracheæ converge as shown in text fig. 3, *B*. The base of the ganglionic trachea is distinctly swollen, forming a special chamber as shown in text fig. 2, *C*. This swelling is thought to be a vestigial spiracular chamber, or atrium. The paratergal tubercle (*t*) and the spiracular swelling are connected by a delicate ribbon (*ct*). This ribbon acts as a segmental support for the tracheal system, although its original nature—whether it is merely a connective tissue or a stigmatic cord derived from the old atrium now shriveled—is not known. The vestigial spiracle of the eighth abdominal segment is found on the cephalic part of the dorsum. The spiracular support connects the spiracular swelling with the cephalic tubercle found at the base of the dorsal paratergal projection in the male and with that found on the paratergal lobe in the female. From the spiracular swelling of this segment a tracheal stem for the following segment extends caudad.

TRACHEÆ

All the tracheæ of this insect are hyaline and unprovided with especially thickened spiral threads, or tænidia, of the intima, resembling the tracheoles, even in the main tracheal trunk, although the figures given in the text show the tracheæ by tænidiumlike shading. The nomenclature of the tracheæ adopted in this report is based on the position of the tracheæ and the organs on which the main branches of the tracheæ are distributed.

Head and thoracic tracheæ (text fig. 3, A).—From each thoracic spiracle seven main tracheæ arise, and those that arise from the mesothoracic spiracle are distributed into the head, cervix, prothorax, and the cephalic half of the mesothorax and their various appendages, and those from the metathoracic spiracle into the caudal half of the mesothorax and the metathorax and their appendages.

The main tracheæ that arise from the mesothoracic spiracle are as follows:

1. *Dorsocephalic trachea*.—This trachea arises directly as a large independent stem from the spiracle, extended under the

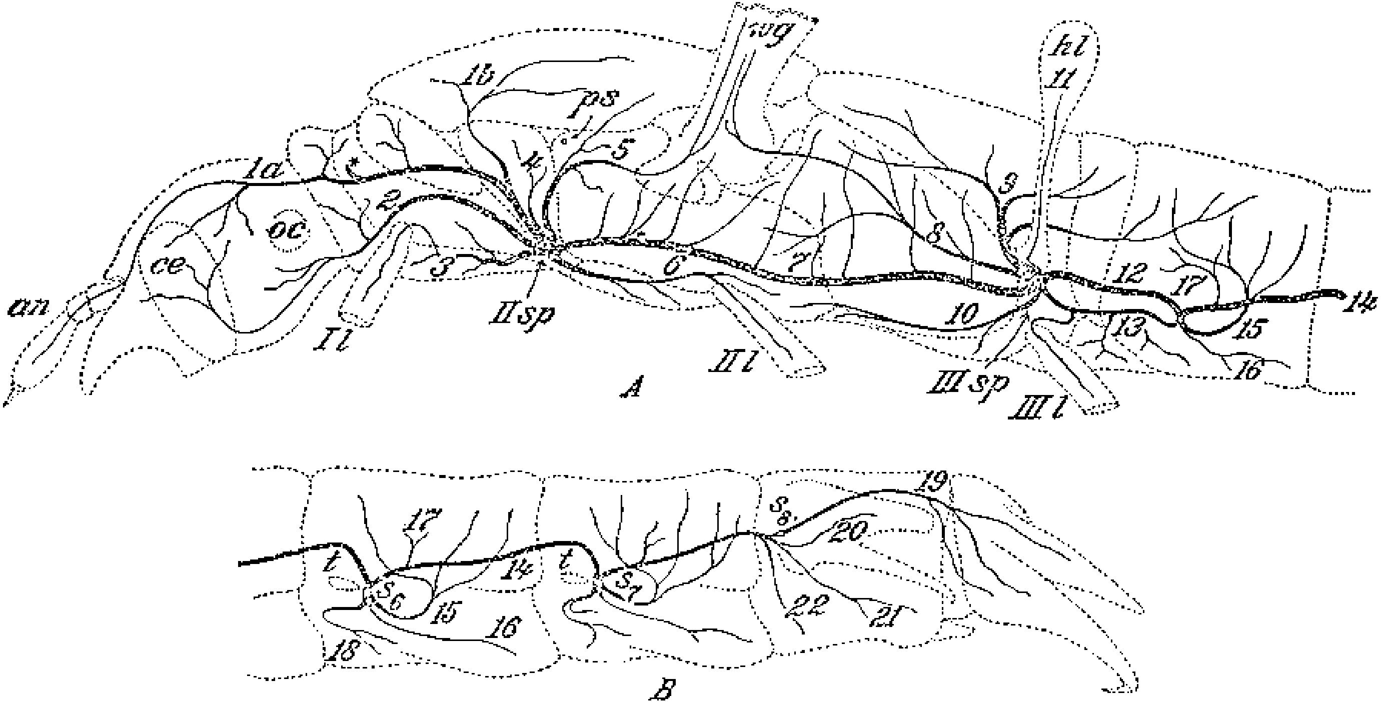

FIG. 8. Tracheal system of *Nymphomyia alba* Tokunaga. *A*, Main tracheæ of head, thorax, and first abdominal segment; *B*, main tracheæ of ultimate four abdominal segments of male; *an*, antenna; *ce*, compound eye; *hl*, halter; *l*, leg; *oc*, ocellus; *ps*, spiraclelike sensory pore; *s*, vestigial spiracle; *sp*, thoracic spiracle; *t*, paratergal tubercle; *wg*, wing; *1* to *22*, main tracheæ; *, transverse commissure.

pronotal plates and on the dorsal side of the head capsule forming a cephalic part of the dorsal trunk. Several tracheal branches issue from this stem. The first large trachea (*1b*) branches off under the postpronotal plate and ends in the tracheoles of the dorsal longitudinal and dorsoventral muscles of the mesothorax; the second branches off under the antepronotal plate and is distributed into the muscles concerned with this sclerite; the third and fourth branches arise on the cervical region and the former forms the transverse commissure (dorsal anastomosed trachea), which is the only commissure for this insect, and the latter ends on the dorsal cervical muscles; after the entrance into the head the fifth fine tracheal branch, which extends into the antenna, branches off and the remaining tracheæ are largely distributed into the supraœsophageal ganglion.

2. *Ventrocephalic trachea.*—This trachea has a very short common base with the propodical trachea and extends along the ventral margin of the pronotal plates and on the ventral side of the head capsule. Three main branches originate from this stem: The first branches off on the cervical region and terminates in the ventral cervical muscles; the second branches off on the head çapsule and ends in the subœsophageal ganglion, and the third branch ends in the supraœsophageal ganglion. The tracheæ of the salivary gland and basipharynx are thought to branch off from this stem, although they were not distinctly demonstrated.

3. *Propodical trachea.*—This trachea extends along the lateral side of the prosternum, is provided with one or two small branches for the prosternal muscles and a small branch for the prothoracic ganglion, and enters into the foreleg.

4. *Pronotal trachea.*—This small trachea is located under the postpronotum, parallel to the dorsal head trachea, at the base appearing to be a branch of the latter stem and ends in the cervical muscles related to the postpronotum.

5. *Alary trachea.*—This trachea is comparatively large, arises as an independent trachea from the spiracle, extends dorsocaudad across the dorsal region of the mesopleuron, and enters the wing. Two small branches for the longitudinal and pleural muscles branch from this wing trachea.

6. *Mesopodical trachea.*—This trachea is also comparatively large, branches from a very short common base with the dorsal tracheal trunk, extends along the lateral side of the mesosternum, and ends in the middle leg. Three main branches arise

from this trachea before it enters the leg cavity; the first is distributed into the cephalic group of the mesosternal muscles, the second into the mesothoracic ganglion, and the last into the caudal group of the mesosternal muscles.

7a. *Dorsocaudal longitudinal trachea.*—This trachea is large and distinct, extending almost straight caudad, forming the main tracheal trunk or dorsal trunk, being anastomosed with the cephalic ends of the dorsocephalic longitudinal trachea of the metathorax. This thoracic tracheal trunk extends for its entire length along the ventrolateral side of the dorsal longitudinal muscle of the mesothorax and is provided with many small branches for the latter muscles and the dorsoventral muscles of this segment.

The metathorax is also provided with seven main tracheæ, which arise from the spiracle.

7b. *Dorsocephalic longitudinal trachea.*—This trachea forms a part of the thoracic tracheal trunk as already alluded to.

8. *Alary trachea.*—This trachea is comparatively large; it extends cephalad across the parascutella and ends in the wing. Under the parascutella several small branches issue for the dorsoventral muscles and the muscles concerned with the latter sclerite.

9. *Dorsal trachea.*—This is a large trachea, separated into three main branches, which are distributed into the postnotal part of the dorsal longitudinal muscles of the mesothorax and, perhaps, into the metapleuron.

10. *Ventral trachea* (*mesopodical trachea*).—This trachea is comparatively large, extends cephalad along the ventral side of the parascutella, is provided with a few branches for the metathoracic ganglion and the caudal group of the mesosternal muscles, and is atrophied before it enters the middle leg.

11. *Haltere trachea.*—This small and delicate trachea arises from the base of the dorsal trachea and ends in the haltere.

12. *Dorsocaudal longitudinal trachea.*—This is a large trachea that extends caudad along the ventral side of the postnotal phragma of the mesothorax and forms a part of the main dorsal trunk (dorsal anastomosed longitudinal trachea), being anastomosed end to end with the dorsocephalic longitudinal trachea of the first abdominal segment. No distinct branch issues from this trachea.

13. *Metapodical trachea.*—This small trachea extends caudad parallel to the dorsal trunk and anastomoses with the ventro-

cephalic trachea of the first abdominal segment, forming the ventral connection. This ventral connection (ventral anastomosed longitudinal trachea) is provided with three main branches, the first of which is distributed to the hind leg, the second to the metasternal muscles, and the third to the sternal muscles of the first abdominal segment.

The ventral trachea of the head, as a rule, is distributed to various trophic organs of the head in addition to the head ganglia. In the present case, however, both external and internal trophic organs are highly reduced and the tracheal branches distributed on these organs were not demonstrated distinctly. According to Lehmann the visceral tracheæ of the thoracic segments typically arise directly from the spiracles, but in *N. alba* the thoracic visceral tracheæ were not observed; and, perhaps, they are greatly reduced, paralleling the reduction of the digestive canal. Concerning the tracheæ for the middle leg and hind leg, Chapman said that the posterior tracheal stem of the leg is fused with the anterior stem of the following segment before the entrance of the leg, and typically they form a Y-shaped anastomosis for each leg. This Y-shaped condition is regularly known in the tracheæ for the middle leg of the Diptera (*Simulium* and *Psychoda*) and that in the hind leg is usually wanting, while in *Nymphomyia* the similar condition is only shown in the hind leg. In the middle leg the anterior tracheal stem from the metathoracic spiracle is atrophied before the base of the middle leg. Although various modifications are reported in different insects by many writers (Lehmann, Kennedy, Kemper, Taylor, et al.), the wing tracheæ originally arise from the bases of the leg tracheæ, and two tracheæ from the different segments are connected by a secondary tracheal bridge at the base of each wing. This condition is retained even in the dipterous halteres in certain Nematocera (*Bittacomorpha*, by Chapman), while in *Nymphomyia* two tracheæ for a wing arise from the spiracles, being basally separated from the leg tracheal stems, and there is no secondary connection between these two wing tracheæ; moreover, the tracheæ for the haltere are represented only by one trachea, which arises from the metathoracic spiracle, not accompanying that arising from the first abdominal segment. Tracheæ for the thoracic ganglia are not fused with those of the opposite side, thus differing from many dipterous insects, which are typically provided with three ventral commissures on the thorax.

Abdominal tracheæ (text fig. 3, B).—The tracheation of the abdominal segments, except that of the two ultimate segments, is closely similar in all the segments. Typically each segment is provided with six main tracheæ, five of which directly arise from the vestigial spiracle, as shown in text fig. 3, *A* and *B*. The main tracheæ of the typical abdominal segment are as follows:

14. *Dorsal longitudinal tracheæ.*—Each of these two tracheæ extends cephalad and caudad along the lateral paratergal fold, respectively; they form the dorsal tracheal trunk, being connected anteriorly and posteriorly with those of the adjacent segments.

15. *Large dorsal and visceral tracheæ.*—These two tracheæ form a common stem, which extends ventrocaudad from the vestigial spiracle, and the majority of the branches are distributed on the dorsal muscles and only a few branches end in the visceral organs, especially the reproductive organs.

16. *Ventrocaudal trachea (ganglionic trachea)*.—This is a fine trachea that extends into the abdominal ganglion and is without distinct branches.

17. *Small dorsal trachea.*—This is a small branch of the dorsocaudal longitudinal trachea and is distributed into the tergal muscles and perhaps into the dorsal vessel.

18. *Ventrocephalic trachea.*—This trachea is distributed to the sternal and pleural muscles. In the first abdominal segment, as already alluded to, this trachea forms the ventral connection, being fused with the trachea for the hind leg.

In the two ultimate segments the tracheal distribution is different from that of the preceding segments. In the eighth segment there are four main tracheæ, of which the ventral three are distributed into the eighth segment and the other extends far caudad, ending in the ultimate segment.

19. *Dorsocaudal longitudinal trachea (large dorsal trachea)*.—This trachea arises from the vestigial spiracle of the eighth abdominal segment, extends caudad, forming the caudal part of the dorsal trunk, and branches off into three delicate tracheæ. These branches end in the reproductive organs and the muscles related to the cercus and coxite when present.

20. *Small dorsal trachea.*—This is a small trachea mainly distributed on the dorsal muscles of the eighth segment.

21. *Ventrocaudal trachea.*—This small trachea extends caudoventrad and ends in the reproductive organs in this segment and in the eighth abdominal ganglion.

22. *Ventrocephalic trachea.*—This is also a small trachea, which ends in the sternal muscles of the eighth segment.

The visceral tracheæ of the abdomen of *N. alba*, except those of the ultimate two segments, are more or less reduced and do not arise as the independent tracheal stems, differing from those of many dipterous insects. Typically, in the present fly, there are no intersegmental ventral connections, all the ventral and ganglionic tracheæ ending intrasegmentally. The transverse commissures are also wanting in the abdomen, the large dorsal trachea being atrophied before the connection with that of the opposite side, differing in this respect from the dipterous insects in general.

DIGESTIVE SYSTEM

The alimentary canal of the adult of *Nymphomyia alba* is simple, very poor in development, slightly convoluted on its caudal part, and divisible into three regions and several subregions morphologically and histologically (text fig. 4).

The first region, the fore intestine (*f-int*), is slender, extended caudad to the cephalic margin of the metasternum. The anterior portion of the fore intestine (*bx-op*), as reported in my previous paper (1935), consists of a short basipharynx and a large œsophageal pump and is provided with characteristic dilator muscles (dilator of pharynx, muscles of salivary pump, anterior dorsal dilator of œsophageal pump, posterior dorsal and ventral dilators of œsophageal pump). Histologically this anterior portion is invested with a thick common layer of ring muscles and lined with a thick layer of chitinous intima. The epithelial layer of this portion is comparatively thick and the epithelial nuclei are large and oval. The posterior portion of the fore intestine, the œsophagus (*oe*), is a very delicate slender canal and without an accessory muscular system (Plate 1, fig. 1). The epithelial layer is reduced to a very thin membrane, and the nuclei (*dn*) are also highly degenerated, being represented by small discoidal masses of chromatin. The chitinous intima (*ch*) is also very thin. Often the wall of the œsophagus seems to be represented by a single, delicate, structureless membrane, the

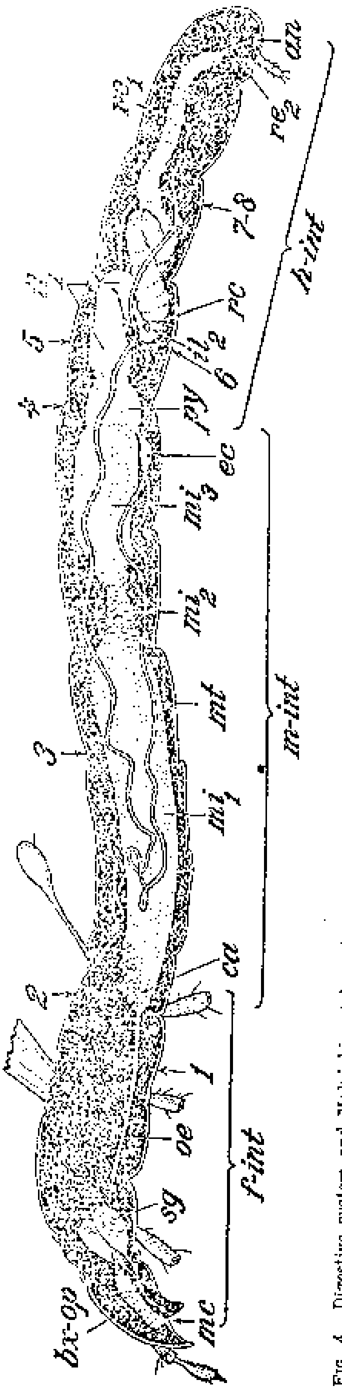

FIG. 4. Digestive system and Malpighian tubes of *Nymphomyia alba* Tokunaga. *an*, Anus; *bx*, basipharynx; *ca*, cardia; *ec*, excretory chamber; *f-int*, fore intestine; *h-int*, hind intestine; *il*, ileum; *mc*, mouth cavity; *mi* and *m-int*, middle intestine; *oe*, oesophagus; *op*, oesophageal pump; *py*, pylorus; *rc*, rectal constriction; *re*, rectum; *sg*, salivary gland; *1-8*, cross sections of alimentary canal illustrated in Plate 1.

epithelium being almost completely degenerated and the two layers, intima and basement membrane, being directly and closely applied to each other.

This fly has no trace of a crop, or sucking stomach, thus differing from the flies provided with junctional trophic organs. With regard to the reduction of the crop of a chironomid fly, Miall and Hammon (1900) state that before the pupation the œsophagus is expanded, forming a ventral diverticulum, which probably represents the sucking stomach of some winged Diptera, but it shrinks rather rapidly and in the late pupa is nearly obliterated, the epithelium being then irregularly folded. Throughout the fore intestine neither longitudinal muscles nor peritoneal membrane was found.

In the dipterous larva, as a rule, the cardiac structures are well developed, being provided with the cardiac valvula, ring muscles, or sphincter muscles, cardiac gland cells, and sometimes with the enteric cæcum. In the imaginal stage, however, these structures are more or less modified or reduced, especially in short-lived flies. In the present insect the cardiac portion (*ca*) is highly reduced, being macroscopically represented by a small, irregularly folded portion at the junction between the fore and the middle intestines. The cardiac valvula formed by the diverticulum of the fore intestine into the enteric cœlom is almost completely reduced as in a psychodid adult (Hövener). The epithelial layer of this portion (Plate 1, fig. 2) remains a comparatively thick syncytiumlike cellular layer and is provided with small oval nuclei. The peritrophic membrane (*pm*) is secreted from this portion of the epithelium. Although Hövener (1930), in the case of *Psychoda,* showed the three different cardiac cell groups differentiated from the cardiac epithelium of the middle intestine and the double nature of the peritrophic membrane, in *N. alba* these features were not observed, the cardiac epithelium consisting of a uniform cellular layer and the peritrophic membrane being a single layer. Chemically, from the peritrophic membrane the chitin substance was detected by Campbell as well as from the exoskeletons of various insects. Judging from this fact these cardiac glandular cells are thought to be ectodermal in origin as in the epithelium of the fore intestine.

The middle intestine (*m-int*) is very large, occupying almost the entire body cavity of the first five abdominal segments, distinctly constricted and rarely slightly convoluted at the fourth abdominal segment. In life the middle intestine is filled with watery hyaline fluid and contains gas bubbles. The wall of the anterior (mi_1) and of the posterior portion (mi_3) of the middle intestine is very delicate, consisting of a very thin basement membrane as shown in Plate 1, fig. 3. The epithelium (*dep*) is highly or almost completely degenerated, as in the œsophageal portion, and no sign of secretion or absorption was demonstrated. A similar feature of the middle intestine is also known in a chironomid imago (Miall and Hammond). In the constricted portion (mi_2) the epithelium is similar in structure to the other parts of the middle intestine, but there is a specially developed additional muscular investment, which consists of very delicate ring muscles and dorsal and ventral longitudinal muscles.

Just behind the posterior portion of the middle intestine there is a short cœlum of the pylorus (*py*). This portion (Plate 1, fig. 4) is lined with chitinous intima (*ch*), showing the ectodermal origin, and the epithelium is comparatively thick. In a typical fly this portion is provided with a valvula at the entrance of the pylorus, but in *N. alba* this pyloric valvula is not developed. The muscular investment is also wanting.

The main region of the hind intestine (*h-int*) is divisible into the ileum (*il*) and the rectum (*re*) by a constriction (*rc*), and each of these portions is convoluted twice. The ileum is subdivisible into a large anterior (il_1) and a small posterior part (il_2). The anterior ileum (Plate 1, fig. 5) is provided with a ring-muscular investment (*cm*); the epithelium consists of a flattened cellular layer, and the epithelial nuclei (*ne*) are large and irregular in shape. While in the posterior ileum (Plate 1, fig. 6) the muscular investment is wanting, the epithelium is comparatively thick and the epithelial nuclei are small, being degenerated into chromatic masses. At the constriction (*rc*) of the hind intestine the ileum is folded into the rectum, forming a small valvula, as in *Psychoda* (Hövener).

The rectum is subdivisible into a large anterior (re_1) and a very small posterior portion (re_2). The anterior portion (Plate 1, figs. 7 and 8) is invested with a strong ring-muscular layer, which is closely applied on the thick epithelial layer. The epithelial cells (*ep*) are somewhat columnar in appearance. This feature may be due to the folding of the flattened epithelium, which is originally similar in structure to that of the anterior portion of the ileum, by the contraction of the strong ring muscles. The posterior portion of the rectum is similar in histologic structure to the œsophageal portion, merely consisting of the chitinous intima and basement membrane, and the epithelium being almost completely degenerated. At the end of this posterior portion there is a small anal sphincter. Throughout the hind intestine the basement membrane (*bm*) is slightly thicker than in the other region, and the peritoneal membrane (*ptm*) is more developed. The special rectal glands or glandular cells were not found.

The paired large salivary glands (*sg*) are retained in the present fly, thus differing from *Psychoda* and *Chironomus*. However, the wall of the gland is reduced to a very thin membrane, the epithelium being almost completely degenerated and the nuclei being also reduced to compact masses of chromatic granules. The epithelium of the neck region alone remains as a comparatively thick layer, but shows no secretory feature of the saliva. The salivary duct is lined with chitinous intima, which shows a tænidiumlike spiral structure as in the trachea, and its epithelium has become very thin. At the anterior end of the common salivary duct there is a salivary pump, which is provided with a group of special muscles as I have already stated (1935).

As mentioned above, the digestive system of *N. alba*, although more or less modified or reduced, is provided with various structures corresponding to those of the typical alimentary canal of an insect. However, histologic research yields no evidence of a digestive function. Probably the digestive system retains merely its external appearance as a remnant of the preëxistent functional organ and is now reduced to a nonfunctional organ.

MALPIGHIAN TUBES

The number of the Malpighian tubes is four in the Diptera in general, and exceptionally an uneven number (three or five) is known, in *Forcipomyia* (Saunders), *Culex* (Schindler), *Psychoda* (Hövener), and *Deuterophlebia* (Pulikovsky). These oligonephric conditions of the Diptera are derived from the original six-tube condition by reduction, but not by fusion (Schindler and Wheeler). In *N. alba* there are only two tubes, probably the minimum number for the Diptera. The paired tubes, as shown in text fig. 4, extend cephalad along the ventrolateral sides of the alimentary canal, turn backwards in the first abdominal segment, then extend caudad along the dorsolateral sides of the alimentary canal, and end freely in the eighth abdominal segment. The first ventral section of the Malpighian tube is slenderer and less curly than the second dorsal section, but there is no other morphologic or histologic difference between these two sections. Throughout the entire length of the tube the cells are linearly arranged, the central cœlom (*cc*) of the tube, then, being represented by the longitudinal communication of the intracellular canal as shown in text fig. 5. The greater part of the tube is black or dark brown due to the pigmentation of colored granules (*pg*); several of the most proximal cells are hyaline and contain no pigmented granules.

Histologically the Malpighian tube is invested with a very delicate basement membrane (*bm*). The cell is comparatively large, with a very large oval nucleus (*n*), many small spherical black or dark brown pigmented granules (*pg*), and two or three intracellular canaliculi (*ic*), which communicate with the central canal (*cc*). The inner surface of the cell forms a special protoplasmic zone (*iz*), which is more strongly stained with eosin dye than the other part, but does not exhibit the structure known as "Stäbchensaum." In many species the cells of the Malpighian tubes exhibit outer peripheral striæ, but in *N. alba* this striated appearance was not observed. The muscular investment is also wanting.

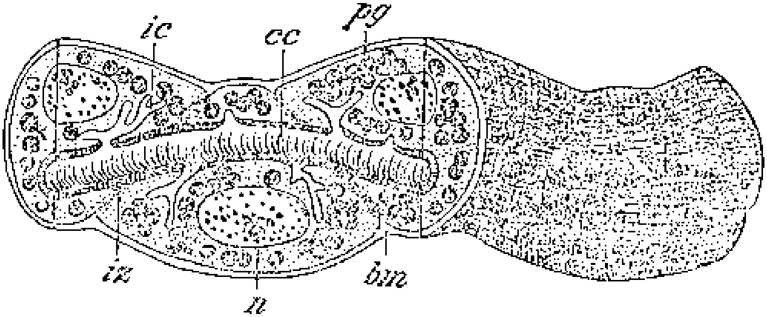

FIG. 5. Semidiagrammatic structure of Malpighian tube of *Nymphomyia alba* Tokunaga. *bm*, Basement membrane; *cc*, central canal; *ic*, intracellular canaliculus; *iz*, inner protoplasmic zone; *n*, nucleus; *pg*, pigment granule.

The two Malpighian tubes (*mt*) of the present insect open into an unpaired, common, excretory chamber, or bladder (*ec*). This chamber is located on the ventral side of the posterior end of the middle intestine, opens into the pylorus at the junction between the middle and hind intestines, and pulsates slowly in life. The presence of the excretory chambers, or common urinary ducts, is known in many insects, such as *Hippobosca*, *Musca*, *Sarcophaga*, *Anthrax*, *Conops*, *Oestrus*, and *Syrphus* (Schindler); in these genera, however, the excretory chambers are paired and at least two in number, each being present on the lateral side of the alimentary canal, highly different from the condition in the present insect. This unpaired condition of *Nymphomyia* may be due to the fusion of the originally paired chambers. Histologically the excretory chamber consists of a thin flattened epithelium and a delicate peritoneal membrane, which contains fine, reticular, muscular fibers. The chitinous intima was not observed.

SUMMARY

The anatomical investigation of the central nervous, tracheal, and digestive systems and their accessory organs in *Nymphomyia alba* is summarized as follows:

1. The metameric arrangement of the neurospongium of the supracœsophageal ganglion is distinct, while that of the subœsophageal ganglion is very obscure, and the neurospongium forms a compact ganglionic mass.

2. The protocerebrum is subdivisible into several distinct lobes. The optic lobes are extended cephalad and closely united with each other on the mesal margins. The lateral ocelli are directly connected with the posterior ventral lobes of the protocerebrum, highly differing in position from the primary adult ocelli. The mushroom bodies are very small. The protocerebral bridge and central body are well developed and arranged in a horizontal plane. The antennary nerves are well developed.

3. The sympathetic nervous system and the nerves originating from the subœsophageal ganglion are highly reduced in relation to the extreme reduction of the external and internal trophic organs.

4. Three thoracic and eight abdominal ganglia are distinctly isolated from each other, and throughout the thorax and abdomen the paired longitudinal series of neuromeres are loosely fused by transverse commissures. These features of the thoracic and abdominal ganglia are thought to suggest the primitive condition of the dipterous nervous system.

5. There are only two pairs of functional spiracles throughout the entire length of the insect; namely, the meso- and metathoracic spiracles. Each thoracic spiracle is provided with a closing apparatus, which consists of two spiracular muscles and a spiracular chitin ring.

6. The abdominal spiracles are greatly reduced and always closed. The trace of spiracles is shown on the first eight abdominal segments. The vestigial spiracle typically consists of a reduced atrium and a delicate ligamentous support, which connects the atrium and the paratergal tubercle.

7. The tracheal system is very simple and provided with a few tracheal anastomoses. The main longitudinal tracheal trunk is represented only by the dorsal intersegmental anastomoses throughout the entire length. The ventral intersegmental tracheal anastomoses are shown only between the metathorax and the first abdominal segment. The transverse anastomosis occurs only on the dorsal side of the cervical region, all the other commissures being reduced.

8. From each thoracic spiracle seven main tracheal stems arise and typically each abdominal segment is provided with five main tracheal stems. The distribution of these tracheæ is discussed in the text.

9. Throughout the entire length of the alimentary canal, the following regions, which fully correspond to those of the

typical digestive system of the insect, are noted: Basipharynx, œsophageal pump, œsophagus, cardiac valvula, stomach, pylorus, ileum, rectum, and salivary glands.

10. The development of the muscular layer and epithelial layer of the alimentary canal is very poor, especially in the region of the midintestine. Histologically there is no evidence of a digestive function, and probably the canal is reduced to a nonfunctional organ.

11. There are only two Malpighian tubes, which open into an unpaired, common, ventral, excretory chamber. Each tube consists of canaliculate cells, which are serially arranged in a row.

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ILLUSTRATIONS

PLATE 1. CROSS SECTIONS OF THE ALIMENTARY CANAL OF NYMPHOMYIA ALBA TOKUNAGA

FIG. 1. Œsophageal portion.
2. Cardiac portion.
3. Anterior portion of midintestine.
4. Pyloric portion.
5. Anterior portion of ileum.
6. Posterior portion of ileum.
7. Anterior portion of rectum through the intercalary part between ring muscles.
8. Anterior portion of rectum through ring muscle.
9. Malpighian tube.

bm, Basement membrane; *ch*, chitinous intima; *cm*, circular or ring muscle; *dep*, degenerated epithelium; *dn*, degenerated nucleus; *ic*, intracellular canaliculus; *iz*, inner zone; *n*, nucleus; *ne*, epithelial nucleus; *nm*, nucleus of muscle; *pg*, pigmental granule; *pm*, peritrophic membrane; *ptm*, peritoneal membrane; *sp*, sarcoplasma.

TEXT FIGURES

FIG. 1. Central nervous system of *Nymphomyia alba* Tokunaga. *A*, Arrangement of ganglia; *B* and *C*, dorsal and ventral aspects of supraœsophageal ganglion, showing metameric structure of neurospongium (cortical layer of ganglionic cells represented by black parts); *ag*, abdominal ganglion; *ann*, antennary nerve; *as*, abdominal segment; *cb*, central body; *ce*, compound eye; *cx*, calix; *dl*, deutocerebral lobe; *dpp*, middorsal lobe; *eo*, epiopticon; *fg*, frontal ganglion; *fl*, frontal lobe; *icp*, intercerebral part; *l*, leg; *mb*, mushroom body; *o*, opticon; *oc*, ocellus; *ol*, optic lobe; *pcb*, protocerebral lobe; *pl–ad*, anterior dorsal lobe; *pl–pd*, posterior dorsal lobe; *pl–pv*, posterior ventral lobe of protocerebrum; *po*, periopticon; *poc*, paraœsophageal connective; *sbg*, subœsophageal ganglion; *spg*, supraœsophageal ganglion; *thg*, thoracic ganglion; *tl*, tritocerebral lobe.

2. Spiracles of *Nymphomyia alba* Tokunaga. *A*, Metathoracic spiracle; *B*, diagrammatic structure of thoracic spiracle showing closing apparatus; *C*, vestigial spiracle of first abdominal segment; *cr*, direction of action of chitin ring; *ct*, ligamentous support; *ma*, direction of muscular action; *s*, spiracular chamber; *sm*, spiracular muscle; *sr*, closing spiracular chitin ring; *t*, paratergal tubercle; *tr*, trachea.

3. Tracheal system of *Nymphomyia alba* Tokunaga. *A*, Main tracheæ of head, thorax, and first abdominal segment; *B*, main tracheæ of ultimate four abdominal segments of male; *an*, antenna; *ce*,

compound eye; *hl*, halter; *l*, leg; *oc*, ocellus; *ps*, spiraclelike sensory pore; *s*, vestigial spiracle; *sp*, thoracic spiracle; *t*, paratergal tubercle; *wg*, wing; *1* to *22*, main tracheæ; *, transverse commissure.

FIG. 4. Digestive system and Malpighian tubes of *Nymphomyia alba* Tokunaga. *an*, Anus; *bx-op*, basipharynx; *ca*, cardia; *ec*, excretory chamber; *f-int*, fore intestine; *h-int*, hind intestine; *il*, ileum; *mc*, mouth cavity; *mi*, and *m-int*, middle intestine; *oe*, œsophagus; *op*, œsophageal pump; *py*, pylorus; *rc*, rectal constriction; *re*, rectum; *sg*, salivary gland; *1-8*, cross sections of alimentary canal illustrated in Plate 1.

5. Semidiagrammatic structure of Malpighian tube of *Nymphomyia alba* Tokunaga. *bm*, Basement membrane; *cc*, central canal; *ic*, intracellular canaliculus; *iz*, inner protoplasmic zone; *n*, nucleus; *pg*, pigment granule.

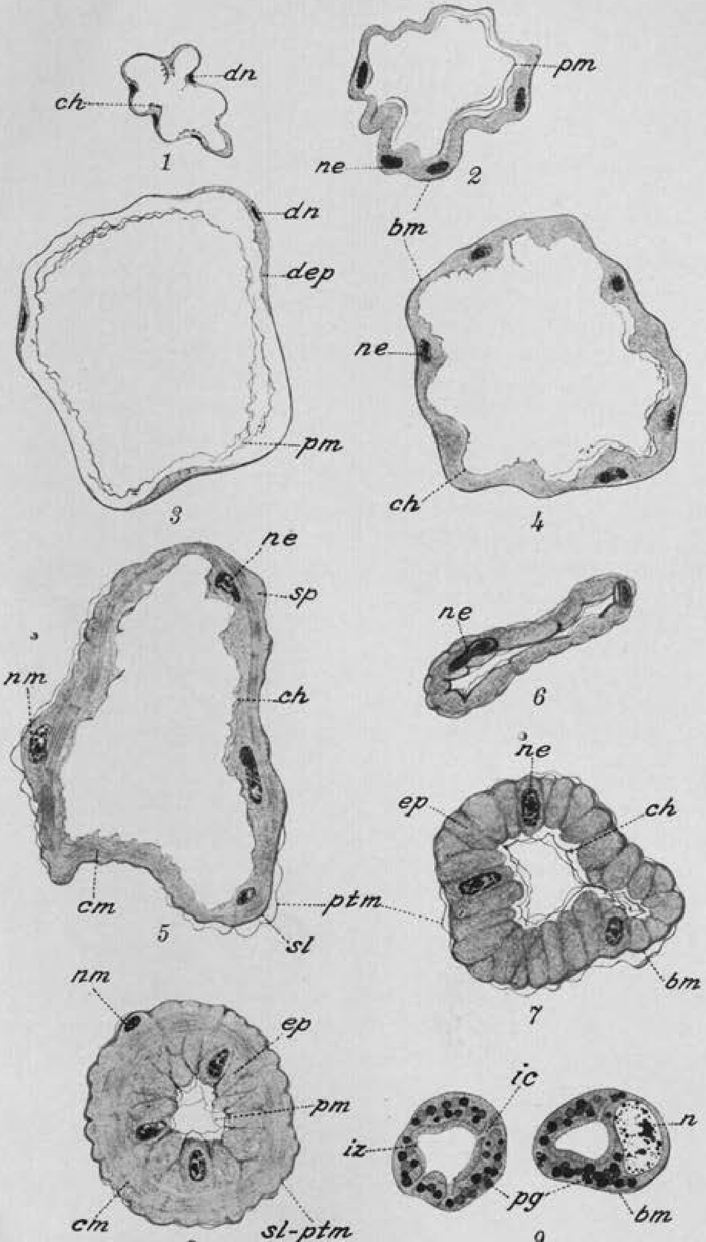
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PLATE 1.

NEW WHITE FLIES FROM THE PHILIPPINES AND FORMOSA (ALEYRODIDÆ; HEMIPTERA)

By RYOICHI TAKAHASHI

Of the Department of Agriculture, Government Research Institute, Formosa

ONE TEXT FIGURE

DIALEURODES (GIGALEURODES) PHILIPPINENSIS sp. nov.

Pupal case.—Brown in dried specimens, with no secretion evident. Very broad, subcircular, a little wider than long, broadest on the posterior part of cephalothorax, very broadly rounded on the anterior margin, broadly so on the hind margin, not constricted across the thoracic tracheal pores, not indented at the hind end, flattened, thin, without papillæ, ridges, or long setæ. Midthoracic suture thin, not reaching the margin; suture between the meso- and metanota not eminent; transverse suture between the thorax and abdomen thin, extending cephalad on the lateral part, nearly reaching the mesonotum, but not the margin of pupa case; abdominal segments discernible only on the narrow median area; rachis absent. Dorsum with many dense reticulations except on the narrow marginal area, many long thin lines running mesad from the margin, and many very small circular pores sparsely scattered except on the very narrow marginal area; about four pores scattered in an area of about 0.092 mm square; a pair of usual setæ near the vasiform orifice rather short; paler areas absent. Margin thin, with no distinct teeth, as in *Dialeurodes struthanthi* Hempel[1] with the usual two pairs of setæ rather short. Thoracic tracheal folds distinct, very long, narrow, gradually broadened towards the base, without sculptures, but with numerous minute dots, broadly sclerotized at the distal end along the pore, the sclerotized part nearly semilunar; thoracic tracheal pores small, closed, a little apart from the margin, directed laterally, without distinct teeth. Caudal furrow distinct, very long, narrow, much expanded at the base, not thickened on the lateral margin, reaching the anterior margin of vasiform orifice, with numerous polygonal sculptures, which are densely arranged in transverse

[1] Proc. U. S. Nat. Mus. 51: pl. 72, fig. 3.

rows on the basal part and elongated on the small distal part; the distal pore like the thoracic tracheal pores. Ventral caudal fold much expanded anteriorly, with numerous minute dots. Vasiform orifice small, wider than long, rounded on the lateral and hind margins, thickened on the margin, not notched, without teeth, the anterior marginal area not well defined, not much expanded. Operculum wider than long, truncate on the hind margin, nearly filling the orifice. Lingula setose, usually not exposed.

Pupal case about 2.3 mm long, about 2.4 mm wide; vasiform orifice, including margin, about 0.074 mm wide; distance between vasiform orifice and hind end of pupal case about 0.53 mm; diameter of dorsal pore about 0.009 mm.

A few specimens were taken on an unknown tree imported from Manila, June 6, 1932, at the plant quarantine station, Takao, Formosa. This species resembles *Dialeurodes* (*Gigaleurodes*) *lithocarpi* Takahashi in th epupal case being wider than long, but differs from the latter in the pupal case being more rounded, the absence of paler areas on the dorsum, the structures of thoracic tracheal pores, and in other features.

DIALEURODES (RUSOSTIGMA) TRISTYLII Takahashi var. UICHANCOI var. nov.

Pupal case.—Differs from the typical form[2] in the following characters: Dorsum with larger circular pores sparsely scattered, eminent, and about 0.009 to 0.0095 mm in diameter; abdominal segments with no pair of markings along the anterior margin; vasiform orifice somewhat wider, more narrowed towards the hind end.

Pupal case about 1.66 mm long, 1.45 mm wide; vasiform orifice, including margin, about 0.065 mm wide.

A few specimens were collected on an undetermined tree imported from Manila, June 6, 1932, at the plant quarantine station, Takao, Formosa. Named for Prof. L. B. Uichanco, professor of entomology, College of Agriculture, Laguna, Luzon. In this variety, as in the typical form, the caudal furrow is a little narrower than the vasiform orifice; the vasiform orifice is very slightly notched at the hind end, with a very small median tooth close to the hind end and with about two, indistinct, minute marginal teeth, which are hardly discernible in some specimens; a pair of very short setæ is present near the base of the vasiform orifice; and the ventral tracheal folds bear numerous minute dots.

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[2] Dept. Agr., Gov't. Res. Inst. Formosa, Rept. 66: 48.

DIALEURODES CITRI Ashmead var. **HEDERÆ** var. nov.

Pupal case.—Differs from the typical form as follows: Dorsum sometimes with a narrow, longitudinal, blackish brown median patch, which reaches the vasiform orifice, but not the front margin of pupal case, and is sometimes interrupted on the thorax and abdomen; venter irregularly reticulated, with many rather large faint markings, mostly circular and with a broad border, scattered, except on the narrow marginal area.

Pupal case about 1.68 mm long, about 1.39 mm wide; diameter of ventral circular marking, including margin, about 0.32 mm; vasiform orifice about 0.046 mm long excluding anterior marginal area, about 0.06 mm wide including margin; distance between vasiform orifice and hind end of pupal case about 0.25 mm.

Hosts.—*Hedera formosana, Helicia* sp.

Habitats.—Formosa: Piyanan-ambu; Reimei, Hassensan; Rarasan near Urai; Izumo, Taito-cho.

Very abundant in the mountainous regions. Described from specimens taken by me on *Hedera formosana,* at Izumo, May 16, 1935. In some specimens collected on *Helicia* sp. at Rarasan, the dorsal patch is much wider. Differs from *Dialeurodes citri* Ashmead var. *kinyana* Takahashi in the much narrower dorsal patch and in the presence of more distinct, circular, ventral markings. In the variety *kinyana* Takahashi the ventral markings are mostly oval, with a distinct, longitudinal, darker area at the center. Easily distinguished from *Dialeurodes kirkaldyi* Kotinsky by possessing a median tooth in the vasiform orifice.

PEALIUS RUBI sp. nov. Text fig. 1.

Pupal case.—White, with a thin secretion along the margin. Elliptic, about 1.5 times as long as wide, not constricted, not indented at the hind end, a little convex on the dorsal disk, soft, asymmetrical in most specimens, with one to four irregular indentations on the margin. Midthoracic suture nearly reaching the margin; sutures between the thoracic segments distinct; transverse suture between the thorax and abdomen not reaching the margin; abdominal segments distinct, but the seventh and eighth not well defined. Dorsum without papillæ or distinct pores, but with many rather short thin lines running mesad from the margin; cephalothorax with three pairs of very long curved setæ, which are subequal in length and reach beyond the margin; a pair of similar setæ on the basal abdominal segment and another pair near the hind end; a short seta present laterad of the basal half of vasiform orifice; basal six abdominal segments with a pair of nearly oval markings on the anterior part. Margin slightly sclerotized, with a pair of short usual setæ on the posterior part; marginal teeth very short, wide, much wider than long, broadly rounded on the distal margin, arranged in a row, about twelve or thirteen teeth occupying a space of 0.092 mm. Thoracic tracheal folds not discernible; combs with four or five teeth in a row, the teeth much narrower, but somewhat more sclerotized, than other marginal teeth, narrowed distally, rounded apically, and wider than long. Caudal furrow narrow, expanded basally, not distinct on the distal end, without distinct markings; comb with

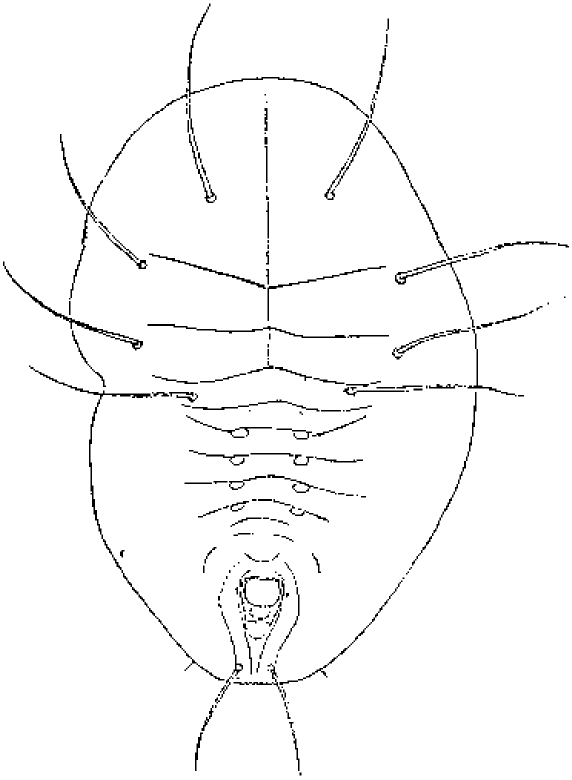

FIG. 1. *Pealius rubi* sp. nov., pupal case.

about five teeth similar to those of the thoracic combs. Vasiform orifice large, nearly as long as wide, somewhat narrowed posteriorly, nearly straight or somewhat indented on the hind margin, a little shorter than the distance between the orifice and the hind end of pupal case, with a few very small pointed teeth on the lateral side; anterior marginal area expanded. Operculum wider than long, straight or very broadly rounded on the hind margin, occupying somewhat more than half the orifice. Ligula setose, knobbed, reaching or not the hind margin of the orifice, the knobbed part wider than long, with a very small lateral protuberance on the base and a pair of long apical setæ. Pit short, narrowed posteriorly, rounded apically, reticulated usually except on the median area. A pair of broad lobes surrounding the vasiform orifice and caudal furrow, reaching the margin.

Pupal case about 0.63 mm long, 0.42 mm wide; vasiform orifice, excluding anterior margin, about 0.048 mm long; distance between vasiform orifice and hind end of pupa case about 0.065 mm.

Host.—*Rubus* sp.

Habitat.—Formosa, Taihoku.

Some specimens were collected by me June 4, 1935. Allied to *Pealius polygoni* Takahashi, but differs in the presence of three pairs of longer and thinner setæ on the cephalothorax, the dorsal markings on the abdomen not distinctly radiating, and the larger vasiform orifice. Resembles *Aleurotrachelus rubi* Takahashi, differs in lacking longitudinal thoracic folds and a median ridge, the presence of a caudal furrow, the much shorter marginal teeth, the vasiform orifice being different in shape and not elevated, each pair of dorsal setæ being more widely separated from each other, and other characters.

The type specimens will be deposited in the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATION

TEXT FIG. 1. *Pealius rubi* sp. nov., pupal case.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXIX[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

TWO PLATES

The species of crane flies discussed below are chiefly from western China, where they were collected by the Rev. Mr. David C. Graham, the material being preserved in the United States National Museum. A second important series is from Japan, collected by Dr. Masaaki Tokunaga, the material being contained in my collection, with duplicates of the species being retained by Doctor Tokunaga. A few additional species from other sources are acknowledged in the text. My sincere thanks are extended to all parties who have thus contributed to this further study of the Asiatic Tipulidæ.

TIPULINÆ

TANYPTERA COGNATA sp. nov. Plate I, fig. 1.

General coloration black, sparsely variegated by yellow; antennæ (male) unusually long, if bent backward extending to beyond base of abdomen; paired branches of flagellar segments long, approximately three times the long-oval unpaired outer branch; posterior femora elongate, black, the extreme base brightened; male hypopygium with dististyle small, dark-colored, narrowed into an acute apical point.

Male.—Length, about 14 millimeters; wing, 13.2.

Rostrum and palpi black. Antennæ black throughout; outer flagellar branch relatively short, long-oval, only about one-third the length of the basal paired branches; antennæ unusually long, if bent backward extending to beyond base of abdomen. Head black.

Pronotum yellow medially, darkened on sides. Mesonotal præscutum polished black, the humeral region restrictedly yellow; scutum, including median area, black, scutellum black, the parascutella obscure yellow; mediotergite black, its cephalic border yellow; pleurotergite chiefly yellow. Pleura dull black, the dorsopleural membrane obscure yellow. Halteres brownish black, the base of stem restrictedly pale. Legs with the coxæ black; trochanters obscure yellow; fore femora obscure yellow basally, the distal third or more passing into black; posterior femora black, only the bases narrowly pale; tibiæ and tarsi black; posterior femora and tibiæ unusually long. Wings (Plate 1, fig. 1) with a strong brownish yellow tinge; prearcular field narrowly clear yellow; stigma oval, brown; a scarcely evident brown wash on anterior cord; veins dark brown. Venation: R_{1+2} entire; R_3 rather strongly upcurved at extreme tip; petiole of cell M_1 longer than m; m-cu on M_4 just beyond origin.

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[1] Contribution from the entomological laboratory, Massachusetts State College.

Basal abdominal tergites yellow laterally, blackened medially; third and succeeding tergites uniformly blackened; sternites of basal half of abdomen yellow, the outer half black. Male hypopygium only moderately enlarged; dististyle small, dark-colored, narrowed to an acute apical point.

Habitat.—China (Szechwan).

Holotype, male, west of Yachow, altitude 2,000 to 7,500 feet, June 14 to 18, 1922 (*Graham*).

The nearest described allies of the present fly are *Tanyptera angustistyla* Alexander, of Japan, and *T. indica* (Brunetti), of the eastern Himalayan region. The former is readily told by the venation and the structure of the male hypopygium, especially the conformation of the outer dististyle. The latter species differs in the coloration of the thorax and abdomen. Both forms apparently have shorter antennæ, with the paired flagellar branches shorter in relation to the unpaired median one. The genus *Tanyptera* had not hitherto been recorded from China.

PSELLIOPHORA STABILIS sp. nov. Plate 1, fig. 2.

Size relatively small (wing, female, 14 millimeters); thorax and outer segments of abdomen uniformly and intensely blackened; head dark liver brown; basal four abdominal segments clear fiery orange; femora uniformly brownish black, with short setæ; posterior tibiæ slender, pale yellowish brown, the proximal fifth paler but not forming an evident ring; wings subhyaline or very faintly tinged with brown; stigma small, pale yellow, inconspicuous; Rs short.

Female.—Length, about 18 millimeters; wing, 14.

Frontal prolongation of head deep brown, short, with powerful nasus; palpi brown. Antennæ dark brown throughout, 10-segmented, the outer flagellar segments becoming more globular; terminal segment pointed at apex, apparently formed by the fusion of two segments. Head uniformly dark liver brown.

Entire thorax black, only feebly nitidous to opaque. Halteres black, the base of stem narrowly paler. Legs with the coxæ dull black; trochanters brownish black; femora uniformly brownish black; tibiæ slender, pale yellowish brown, the basal fifth of the posterior pair more whitish but not forming any sort of a ring; tip of tibia weakly darkened; tarsi dark brown; femora with relatively short and inconspicuous setæ; hind tibiæ unusually slender. Wings (Plate 1, fig. 2) subhyaline or with a very faintly indicated brownish tinge; stigma small, pale yellow, scarcely differentiated; veins brown. Setæ of posterior border beyond squama long and conspicuous. Venation: Rs unusually short in relation to basal section of R_{4+5} being only slightly more than twice as long; R_2 short to punctiform; vein R_3 long-extended; m-cu at fork of M_{3+4}.

Abdomen with basal four segments, together with the very narrow cephalic border of the fifth tergite and the much more extensive corresponding portions of the fifth sternite, fiery orange, immaculate; remainder of abdomen, except tips of valves of ovipositor, black.

Habitat.—China (Yunnan).

Holotype, female, Psaotung (*Graham*).

In its general appearance, the present fly resembles a small *Pselliophora ctenophorina* Riedel or *P. speciosa* Edwards, but is readily told by the subhyaline wings and lack of a white ring on the tibiæ, including the posterior pair.

PSELLIOPHORA LAUTA sp. nov. Plate 1, fig. 3.

General coloration black, the præscutum with the lateral borders brightened; fore and middle femora yellow, posterior femora black, the tips narrowly yellow; tibiæ orange-yellow, with a vague, poorly defined, whitish ring close to base; wings dark brown, the narrow basal portion, costal border, and a crossband before cord yellow; abdominal tergites ringed yellow and black, the apices of the latter color.

Female.—Length, about 19 millimeters; wing, 15.

Rostrum and palpi black, the terminal segment of the latter elongate. Antennæ with the scape and pedicel black, flagellum brownish black to brown, the segment oval, sessile. Head velvety black.

Pronotum velvety black. Mesonotum black, the intermediate præscutal stripes more reddish; lateral borders of præscutum between the humeral region and suture conspicuously reddish yellow. Pleura black throughout. Halteres black. Legs with the coxæ and trochanters black, the apices of the latter narrowly brightened; fore and middle femora yellow; posterior femora black, the apices narrowly yellow; tibiæ orange-yellow, with a very ill-defined more whitish yellow ring near base; tarsi broken. Wings (Plate 1, fig. 3) with the ground color rather dark brown, conspicuously variegated by yellow, the latter color including the prearcular region, very narrow bases of cells R to 2d A, inclusive, and almost all of cells C and Sc, the outer ends of the latter being darkened; an arcuated yellow crossband extending across wing from stigma to outer end of cell Cu, traversing the outer ends of cells R and M just before their extreme tips; a yellow spot in outer end of cell 1st A; all cells beyond cord uniformly darkened; extreme wing base darkened; postsquamal setæ long and conspicuous; veins brown in the darkened areas, more yellowish where traversing yellow areas. Venation: Cell M_1 narrowly sessile; cell M_4 narrowed at margin.

Abdomen with basal tergite velvety black; succeeding tergites with bases yellow, the apices black, the amount of the latter color increasing outwardly until on the seventh tergite only the lateral basal angles are brightened; outer tergite uniformly darkened; second and third sternites very extensively yellow, the outer sternites patterned about as on the corresponding tergites.

Habitat.—China (Szechwan).

Holotype, female, Fulin, altitude 3,000 to 7,000 feet, August 18 to 21, 1928 (*Graham*).

The most closely allied species are *Pselliophora bifasciipennis* Brunetti and *P. fumiplena* (Walker), which have a very different leg pattern. The possibility is not excluded that the present fly may be only subspecifically distinct from *fumiplena*, but it certainly appears to represent a valid species.

DICTENIDIA LUTEICOSTALIS sp. nov. Plate 1, fig. 4.

General coloration yellow, the mesonotal præscutum with an elongate, median, wedge-shaped, blackened mark, the long point directed backward; femora yellow; posterior tibiæ enlarged, yellow, the narrow tips and broader ring on basal half black;

wings strongly suffused with yellow, especially the wide costal border, the disk almost immaculate; veins black; macrotrichia in outer ends of cells R_3 to M_1, inclusive; abdomen orange-yellow, the tergites with a narrow, interrupted, median vitta on the basal four segments.

Female.—Length, about 14 millimeters; wing, 12.

Frontal prolongation of head yellow, without clearly defined nasus, the outer end more dusky; palpi yellow, the elongate terminal segment a trifle darkened at outer end. Antennæ chiefly yellow, the scape and outer edges of flagellar serrations more dusky; antennæ 11-segmented, the six intermediate flagellar segments moderately produced on ventral face, the serrations truncate or subtruncate; terminal two segments closely approximated or fused, the last pointed. Head yellow, the anterior vertex with a transverse brown fascia extending from eye to eye, the color continued backward to occiput as a median line.

Pronotum narrow, chiefly infuscated. Mesonotal præscutum polished yellow, with three more reddish yellow stripes, the median one on cephalic portion replaced by an elongate-triangular black wedge, the long point directed behind; posterior sclerites of mesonotum uniformly reddish yellow. Pleura yellow, conspicuously variegated by more reddish areas on the anepisternum. Halteres yellow, the knobs infuscated, the extreme tips slightly paler. Legs with the coxæ and trochanters yellow; forelegs broken; middle legs with femora and tibiæ uniformly yellow; basitarsi brownish black, the remainder of tarsi black; posterior legs with femora uniformly yellow; tibiæ longer and stouter, rather conspicuously arcuated, with long conspicuous setæ; yellow, the tip narrowly black and with a broader black ring occupying the outer end of the basal half; tarsi black. Wings (Plate 1, fig. 4) strongly suffused with yellow, virtually immaculate except for the small brown stigma; narrow and insensibly indicated seams along cord and the wing apex extensively but very slightly infumed; cells R and M a trifle more tinged with brown, the latter with a central pale streak in outer third; cells C, Sc, and Cu_1 more intensely saturated yellow; veins black, conspicuous, the prearcular veins, together with C, Sc, and R, yellow. Rather numerous but small macrotrichia in outer ends of cells R_3, R_5, and M_1, inclusive. Venation: Petiole of cell M_1 subequal to m; cell 1st M_2 small, pentagonal.

Abdomen orange-yellow, the tergites with a narrow, slightly interrupted, median black stripe on basal four segments, the line becoming narrower and more attenuated behind; lateral borders of tergites slightly paler, margined internally by dusky; sternites unmarked. Ovipositor with both cerci and hypovalvæ compressed and with tips obtuse or truncated, the hypovalvæ much shorter.

Habitat.—China (Szechwan).

Holotype, female, between Chengtu and Mowchow, altitude 1,400 to 4,500 feet, July 3 to 10, 1924 (*Graham*).

Despite the fact that the present species is known only from the female sex, I feel certain that the generic reference is correct. The venation and presence of numerous macrotrichia in the apical wing cells is much as in all other known species of the genus, with the exception of the aberrant *Dictenidia inæquipectinata* Alexander, of the high mountains of Formosa. The very strongly yellowish wings and the coloration of the body will serve to separate the present fly from its other relatives in eastern Asia. The genus is new to the fauna of China.

TIPULA (OREOMYZA) CLADOMERA sp. nov. Plate 1, fig. 5; Plate 2, figs. 25, 26.

General coloration brown, pruinose, the præscutum with four brown stripes; antennæ (male) extending nearly to base of abdomen; flagellar segments black, their apices narrowly pale; femora brownish yellow, the tips narrowly blackened; claws (male) toothed; wings pale brown, restrictedly variegated by paler areas before and beyond stigma and across cord; male hypopygium with the outer dististyle very large and of unusual shape, expanded outwardly, the apex with a U-shaped notch to form two conspicuous lobes; eighth sternite with nine or ten very coarse setæ on either side of midline of caudal margin.

Male.—Length, about 15 millimeters; wing, 14.5.

Frontal prolongation of head reddish brown; nasus long and powerful; palpi brownish black. Antennæ moderately long, if bent backward extending nearly to base of abdomen; scape and pedicel light yellow; first flagellar segment light brown, paler at tip; succeeding flagellar segments black, their apices narrowly pale; flagellar segments weakly incised; verticils subequal in length to the segments. Head reddish brown, with a narrow brownish median vitta on vertex, becoming narrower and more attenuated behind.

Mesonotal præscutum brown, pruinose with gray, apparently with four brown stripes that are bordered by darker, this region of body badly discolored in type; scutum brownish gray, the lateral portions darker; scutellum and mediotergite gray with a capillary brown median vitta. Pleura chiefly gray. Halteres pale yellow, the knobs infuscated, with their tips restrictedly pale. Legs with the coxæ brownish gray; trochanters obscure yellow; femora brownish yellow, the tips narrowly blackened, preceded by a vague, clearer yellow ring; tibiæ brown, the tips narrowly blackened; tarsi reddish brown; tibial spur formula 1-2-2; claws (male) toothed. Wings (Plate 1, fig. 5) with a pale brown tinge, cell Sc somewhat darker; stigma small, brown; very restricted paler areas before and beyond stigma and across cell 1st M_2; a more or less distinct brown seam along vein Cu in cell M; veins brown. Venation: R_{1+2} long, entire, with macrotrichia on basal fourth; cell 1st M_2 small, pentagonal.

Basal abdominal tergites yellow, lined with darker; hypopygium yellow. Male hypopygium (Plate 2, fig. 25) with the suture between tergite, 9*t*, and sternite, 9*s*, short. Basistyle at apex produced into a flattened lobule. Ninth tergite (Plate 2, fig. 26, 9*t*) short, entirely pale, with pale setæ; caudal margin with a narrow, U-shaped, median notch that extends fully to midlength of the sclerite; the broad lateral lobes obliquely truncated. Outer dististyle (Plate 2, fig. 26, *od*) very large and of unusual shape, being expanded outwardly and deeply bifid by a U-shaped apical notch; margins of lobes darkened and sclerotized. Inner dististyle (Plate 2, fig. 26, *id*) much smaller, as shown by the figures. Eighth sternite broadly and shallowly notched, the median area with restricted pale membrane, the margin on either side of midline with nine or ten long, unusually coarse setæ, the more lateral ones smaller.

Habitat.—China (Szechwan).

Holotype, male, Wan-hsien, September 14, 1921 (American Museum of Natural History, accession No. 23974).

The very remarkable male hypopygium will serve to separate this species from all others in the genus described to this date. I have compared the fly with my almost complete series of species of this particular faunal area and can find no form with which it may be profitably compared. The great size and unusual conformation of the outer dististyle of the male hypopygium is different from the normal condition in *Oreomyza*, but I believe the species to be correctly referred to this subgenus.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) ARTHRITICA sp. nov. Plate 1, fig. 6.

General coloration of thorax green, the præscutum with three orange stripes; head orange; legs yellowish white, the femoral tips strongly swollen and blackened; all tarsi white, the three outer segments pale brown; wings long and narrow, rich brown, the outer margin in radial field deeper brown; a restricted darker brown pattern on certain of the veins and crossveins; Rs very elongate, angulated at origin; cerci small, slender, strongly upcurved.

Female.—Length, about 5.5 millimeters; wing, 7.5.

Rostrum short, polished black; palpi black. Antennæ with scape and pedicel intense black; flagellum dull black, the proximal ends of the segments indistinctly and vaguely paler; flagellar segments oval to long-oval. Head fiery orange.

Pronotum green. Mesonotal præscutum green, with three orange stripes that are nearly confluent, the interspaces indicated only by delicate vittæ of the ground color; scutum green, the lobes variegated by orange; scutellum and mediotergite green. Pleura strongly suffused with green, presumably fading to yellow in older specimens. Halteres obscure brownish yellow, the knobs infuscated. Legs with the coxæ and trochanters greenish; femora yellowish white, the tips very strongly swollen and heavily blackened, the degree of incrassation and blackening subequal on all legs; tibiæ yellow, the extreme bases blackened, the tips broadly blackened, the amount of the latter involving approximately the distal fifth; all tarsi with basal two segments snowy white, the outer segments pale brown, with segments three and four weakly swollen. Wings (Plate 1, fig. 6) long and narrow, with slender basal petiole; ground color strongly rich brown, the margin in outer radial field suffused with dark brown; restricted darker brown spots and clouds, arranged as follows: Origin of Rs; fork of Sc; free tip of Sc_2 and R_2; cord and outer end of cell 1st M_2; veins pale, somewhat darker in the clouded areas. Macrotrichia of veins beyond cord abundant and well distributed. Axillary angle of wing just beyond squama strongly dilated. Venation: Sc moderately long, Sc_1 ending just before midlength of Rs, Sc_2 close to its tip; Rs very long, angulated at origin; free tip of Sc_2 lying some distance before R_2, the latter gently curved into R_1, with no sign of a spur of R_{1+2}; inner end of cell 1st M_2 strongly arcuated; m at beyond one-third the length of the cell; veins M_{1+2} and M_3 exceeding cell 1st M_2 in length; m-cu at or just before the fork of M; anal veins parallel or very gently divergent at origin.

Abdominal tergites brown, the sternites more greenish yellow; terminal segments more buffy. Ovipositor with the cerci much shorter than the hypovalvæ, slender, strongly upcurved.

Habitat.—Java (west).

Holotype, female, Goenoeng Tjimerang, Djampangs, March, 1935 (*M. E. Walsh*); in author's collection.

The present fly is so different from all other members of the subgenus yet described that comparison with any other species would be unprofitable. The strongly swollen and blackened tips of all femora give to the insect a very strange appearance. It is very probable that the rich green tints of the thorax will fade to yellow or greenish yellow in old specimens.

LIMONIA (LIMONIA) NOMINATA sp. nov.

General coloration of præscutum black, with three reddish brown stripes; pleura almost uniformly darkened; apices of knobs of halteres yellow; femora yellow, the distal end, including apex, blackened, inclosing a narrow yellow ring; wings cream-yellow, very extensively clouded by brown washes that restrict the ground color to narrow, broken, chiefly transverse bands; Sc_2 ending before level of fork of Rs; R_{1+2} shorter than R_{2+3}; cell 1st M_2 relatively small; m-cu beyond the fork of M; abdominal tergites bicolorous, black, the bases of the segments narrowly yellow.

Female.—Length, about 12 millimeters; wing, 12.5.

Rostrum and palpi black. Antennæ brownish black throughout; flagellar segments elongate, the longest verticils somewhat exceeding the segments. Head brownish black.

Pronotum dark brown above, paler on sides. Mesonotal præscutum with the ground color black, with three reddish brown stripes; scutal lobes chiefly blackened, the median region restrictedly pale; scutellum reddish brown; mediotergite dark. Pleura almost uniformly dark brown or brownish black. Halteres relatively long, yellow, the basal half of knob dark brown. Legs with the fore and middle coxæ dark brown, the posterior coxæ paler; trochanters obscure yellow; femora yellow, the tip and a subterminal ring blackish, the two latter inclosing a yellow annulus that is a little more extensive than the darkened apex and much narrower than in the allied *prudentia;* tibiæ and tarsi brown. Wings with the ground color cream-yellow, chiefly concealed by unusually extensive brown clouds and washes, restricting the ground to broken transverse bands beyond the arculus, at middistance between the latter and origin of Rs, beyond the origin of Rs and a long cord; small isolated spots of the ground before and beyond the stigma, near outer end of cell 1st M_2, outer end of cell 2d M_2, and as a spot at near midlength of cell 2d A; cell Cu_1 almost uniformly darkened; veins brown, more yellowish in the ground areas. A series of macrotrichia distributed over almost the whole length of vein Rs, lacking on the basal ascending portion. Venation: Sc relatively short, Sc_2 ending some distance before the fork of Rs, in *prudentia* slightly beyond this fork; Sc_1 shortly removed from the tip of Sc_2; R_{1+2} elongate but shorter than R_{2+3}; cell 1st M_2 small, shorter than the veins issuing from it; m-cu about one-third to one-fourth its length beyond the fork of M.

Abdominal tergites black, the incisures narrowly yellow, including the bases of the sclerites; basal sternites yellow, the outer segments bicolorous, black and yellow, the bases of the latter color. Cerci small and slender.

Habitat.—China (Szechwan).

Holotype, female, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

The nearest allied species appears to be *Limonia* (*Limonia*) *prudentia* Alexander, likewise from western China, which has the leg pattern somewhat similar but with the wing pattern and venation quite distinct.

LIMONIA (DICRANOMYIA) PENITA sp. nov. Plate 1, fig. 7; Plate 2, fig. 27.

Belongs to the *morio* group; size relatively large (wing, male, 8 millimeters); halteres dusky, the base of stem narrowly pale; vein 2d A longer than in *paramorio* but much shorter than in *kongosana;* abdomen black, the posterior portions of the intermediate sternites paler; male hypopygium with the tergal lobes slender; ventromesal lobe of basistyle very broad and obtuse; apex of dorsal dististyle acute; ventral dististyle oval, the rostral prolongation long and slender, subequal in length to the rostral spine.

Male.—Length, about 7.5 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with short apical pedicels. Front conspicuously silvery white; posterior region of head dull brownish black.

Thoracic dorsum polished black, the posterior sclerites a trifle more pruinose. Pleura rather heavily dusted with gray. Halteres elongate, dusky, the base of stem narrowly paler. Legs with the fore coxæ black, remaining coxæ more brownish yellow; trochanters obscure yellow; femora obscure yellow, the tips narrowly and weakly darkened; remainder of legs dark brown to brownish black. Wings (Plate 1, fig. 7) strongly tinged with brown, the stigma still darker brown; veins brown. Venation: Sc_1 ending a short distance beyond origin of Rs, Sc_2 far removed from its tip, Sc_1 alone subequal in length to Rs; free tip of Sc_2 and R_2 in approximate transverse alignment; m-cu shortly before fork of M; vein 2d A elongate.

Abdomen black, the apical portions of the intermediate sternites vaguely paler. Male hypopygium (Plate 2, fig. 27) with the lobes of the tergite, *9t,* moderately stout, but considerably narrower than the width of the U-shaped emargination separating them. Ventromesal lobe of basistyle, *b,* very broad and obtuse, its apex rounded. Dorsal dististyle a slender, gently curved, blackened rod, gradually narrowed to the acute tip. Ventral dististyle, *vd,* of moderate size, pale, oval in outline, the rostral prolongation dusky, slender; a single stout pale spine that is subequal in length to the rostral prolongation beyond its insertion.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

The nearest allies of the present fly are *Limonia (Dicranomyia) kongosana* Alexander, of Korea, and *L. (D.) paramorio* (Alexander), of Japan and eastern China, both of which have the dorsal dististyle acute at apex, the rostral prolongation of the ventral dististyle evident, and the ninth tergite more or less produced into lobes. The present insect is about intermediate in its characters between the indicated species but is amply distinct in the details of the hypopygium.

LIMONIA (RHIPIDIA) ISOSPILOTA sp. nov. Plate 1, fig. 8.

Allied to *maculata;* general coloration (in spirit) dark, the thoracic pleura distinctly striped longitudinally with dark; wings whitish subhyaline, the entire surface abundantly dotted with brown and grayish brown, the latter covering most of disk and being subequal in area to the interspaces; darker costal areas of small size, the spot at end of Sc widely separated from the one at origin of Rs; Sc_1 at or beyond midlength of Rs.

Female.—Length, about 7 to 7.5 millimeters; wing, 5.5 to 6.

Described from alcoholic specimens.

Rostrum and palpi black. Antennæ brownish black, the apical pedicels of the flagellar segments white; flagellar segments moderately produced (female). Head grayish brown.

Mesonotum uniformly darkened, in fresh specimens probably pruinose; lateral portions of præscutum paler. Pleura narrowly lined with still darker, appearing as longitudinal stripes across the ventral anepisternum and ventral sternopleurite. Halteres pale. Legs with the coxæ darkened; trochanters pale; remainder of legs dark brown, the femoral bases a little brightened. Wings (Plate 1, fig. 8) whitish subhyaline, the entire surface abundantly dotted with brown or paler grayish brown areas, of which the former are subequal in size to the latter; none of the darkenings of large size, as is the case in *maculata* and allies; dark spots at tip of Sc_1 and origin of Rs widely separated; stigmal area and clouds at fork of Rs and along m-cu slightly larger; dots in the cells almost equal in area and comparable to the pale interspaces; veins yellowish brown, darker in the clouded areas. Venation: Sc long, Sc_1 ending at or beyond midlength of Rs, Sc_2 at its tip; m-cu approximately one-half its length before the fork of M.

Abdomen relatively pale brown.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Kibune, Kyoto, October 16, 1934 (*Tokunaga*). Paratopotype, alcoholic female.

Limonia (*Rhipidia*) *isospilota* is most readily told from *L.* (*R.*) *maculata* (Meigen) by the unusually long Sc, with the darkened area at its tip widely separated from that at origin of of Rs; from *L.* (*R.*) *triarmata* Alexander it is told by the elongate Sc, which ends opposite or beyond midlength of Rs.

LIMONIA (RHIPIDIA) HYPOMELANIA sp. nov. Plate 1, fig. 9; Plate 2, fig. 28.

Mesonotum and pleurotergite pale yellowish brown, contrasting abruptly with the blackened ventral pleurites and sternum; antennæ (male) with eight bipectinate segments; femora yellow, the bases weakly darkened; wings pale yellow, with very abundant pale brown dots in the cells; Sc relatively long, Sc_1 ending beyond one-third the length of Rs; male hypopygium with five or six long curved spines placed far out near apex of rostral prolongation.

Male.—Length, about 6.5 to 7 millimeters; wing, 7.5 to 8.

Female.—Length, about 7.5 millimeters; wing, 8.

Male.—Rostrum and palpi black. Antennæ with eight bipectinate segments (flagellar segments two to nine, inclusive); scape and pedicel black; flagellar segments with basal enlargements and branches black, the long apical pedicel yellow; longest branches (about flagellar segments four to six) approximately one-half longer than the segment; first flagellar segment merely produced; flagellar segments ten and eleven with a single branch, on the former segment nearly as long as the enlargement; terminal segment about one-half longer than the penultimate. Head black, pruinose, paler behind.

Mesonotum almost uniformly pale yellowish brown, this color including the dorsopleural region and pleurotergite, contrasting abruptly with the blackened propleura, anepisternum, sternopleurite, sternum, and meral region. Halteres pale yellow, the knobs weakly darkened. Legs with the coxæ blackened; trochanters brownish black; femora yellow, the bases weakly darkened; tibiæ and tarsi yellow, the terminal segments of the latter passing into black. Wings (Plate 1, fig. 9) pale yellow, with abundant, very pale brown dots in the cells, these so indistinct as to make the wing appear virtually unicolorous; similar sized but slightly darker dots at the supernumerary crossvein in cell Sc, origin of Rs, fork of Sc, along cord, and on outer end of cell 1st M_2; veins yellow, a little darker in the clouded areas. Venation: Sc relatively long, Sc_1 ending beyond one-third the length of Rs, Sc_2 at its tip; m-cu slightly variable in position in different specimens, from immediately before fork of M to nearly one-half its length before this point.

Abdomen yellowish brown. Male hypopygium (Plate 2, fig. 28) with the caudal margin of tergite, *9t*, almost evenly, convexly rounded. Basistyle, *b*, with the ventromesal lobe broad, with abundant setæ. Dorsal dististyle nearly straight, a little expanded at apex, suddenly narrowed to an apical spine. Ventral dististyle, *vd*, of moderate size, the rostral prolongation long, with five or six long curved spines placed far out near apex.

Female.—Characters as in male, differing only in the sexual features. Flagellar segments simply produced on ventral face.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female, in fragmentary condition, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, male, with the allotype.

The present fly is very distinct from all other regional species of the subgenus, especially in the peculiar pattern of the thorax and in the weakly patterned wings.

ANTOCHA (ANTOCHA) SPICATA sp. nov. Plate 1, fig. 10; Plate 2, fig. 29.

Size small (wing, about 4 to 5 millimeters); general coloration dark; halteres pale; wings grayish, the prearcular field paling to white; veins pale brown, contrasting but little with the ground; vein Sc short; male hypopygium with both dististyles simple; outer gonapophysis bluntly rounded at apex.

Male.—Length, about 3.5 to 4 millimeters; wing, 4 to 5.2.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ with the scape brown, the pedicel and flagellum darker brown; flagellar segments subglobular to very short-oval, the outer segments slightly more elongate. Head dark brown.

Thorax almost uniformly darkened (in spirit), undoubtedly pruinose in fresh specimens; præscutal stripes not clearly evident. Halteres pale. Legs with the coxæ and trochanters brown; remainder of legs uniformly darkened. Wings (Plate 1, fig. 10) with a grayish tinge, the prearcular field paling to white; veins pale brown, contrasting but little with the ground. Venation: Sc short; as in *brevinervis*, Sc_1 ending about opposite two-thirds to three-fourths the length of Rs; r-m at or before one-third the length of cell 1st M_2; m-cu before the fork of M.

Abdomen, including hypopygium, uniformly dark brown. Male hypopygium (Plate 2, fig. 29) with the tergite, *9t*, transverse, the posterior border emarginate medially. Basistyle, *b*, with a setiferous lobe on mesal face at base; setæ of outer face at apex longer and more powerful. Both dististyles, *d*, simple and of generally similar outline, the tip of the outer or glabrous style a trifle more pointed. Ædeagus, *a*, notched at apex. Inner gonapophyses, *g*, appearing as straight simple spikes; outer apophyses shorter, ending in obtuse flattened blades.

Habitat.—Japan (Hokkaido, Honshiu, Kiushiu).

Holotype, alcoholic male, Kibune, Kyoto, Honshiu, October 11, 1934 (*Tokunaga*). Paratypes, 1 male, Date, Iburi, Hokkaido, September 4, 1923 (*S. Kuwayama*); 1 male, Jozankei, Ishikari, Hokkaido, August 19, 1922 (*T. Esaki*); 1 male, Takaharu, Hiuga, Kiushiu, November 1, 1923 (*T. Esaki*). Types in author's collection.

The nearest described ally is *Antocha* (*Antocha*) *brevinervis* Alexander, which has the subcostal vein similarly abbreviated and likewise agrees in its general appearance. The present fly is most readily told by its small size, whitened wing bases, pale wing veins, and differences in the conformation of the ædeagus and outer gonapophyses. In the original definition of *brevinervis*,[2] the present species was confused in the type series; the true holotype of *brevinervis* being from Sapporo, Hokkaido, June 25, 1921, collected by Kuwayama.

ORIMARGA (ORIMARGA) DISTALIS sp. nov. Plate 1, fig. 11; Plate 2, fig. 30.

Mesothorax dark brown; wings uniformly pale yellow, the veins a trifle darker; macrotrichia of veins beyond cord relatively numerous; R_{2+3} about twice R_{1+2}; M_{3+4} a little longer than M_4; m-cu lying unusually far distad, approximately two or two and one-half times its own length before the fork of M and opposite the distal end of Rs; spines at apex of ædeagus long and needlelike.

Male.—Length, about 7.5 millimeters; wing, 6.

Described from an alcoholic specimen.

Rostrum, palpi, and antennæ dark brown; flagellar segments oval, the terminal segment smaller than the penultimate. Head dark brown; anterior vertex about equal to twice the diameter of the scape.

Pronotum elongate, pale brown. Mesonotum (in spirit) uniformly dark brown, without clearly defined markings excepting the slightly brightened humeral region and a very ill-defined, capillary, median pale vitta that extends almost the entire length of the mesonotum. Pleura brown. Halteres white throughout. Legs with the coxæ and trochanters yellowish brown; remainder of legs uniformly brown. Wings (Plate 1, fig. 11) with a uniform pale yellow tinge; veins yellowish brown; costal fringe relatively short; macrotrichia of veins beyond cord relatively numerous, including outer ends of veins R_{1+2} to Cu_1, inclusive. Venation: Sc_1 ending shortly before the fork of Rs; R_{2+3} about twice R_{1+2} alone; free tip of Sc_2 distinct; R_1 a little shorter than R_{1+2}; M_{3+4} a little longer than M_4; m-cu lying unusually far distad, approximately two to two and one-half times its own length before the fork of M and opposite the distal end of Rs.

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[2] Philip. Journ. Sci. 24 (1924) 567.

Abdomen brown, the sternites a little brighter. Male hypopygium (Plate 2, fig. 30) with the paired spines at apex of ædeagus, *a*, long and needlelike; inner gonapophyses, *g*, unusually narrow, weakly notched at tips.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

Orimarga (*Orimarga*) *distalis* is readily distinguished from the other Japanese species of the genus having vein R_{2+3} elongate, by the position of m-cu, which lies far distad, opposite the outer end of Rs. In all other species of this group so far described from China and Japan, m-cu lies three or more times its own length before the fork of M and opposite or before midlength of Rs. The most nearly allied single species is *O.* (*O.*) *yakushimana* Alexander (Kiushiu, Honshiu), which has the inner gonapophyses of the male hypopygium unusually broad, with their apices entire.

HELIUS (HELIUS) LONGINERVIS Edwards.

Helius longinervis EDWARDS, Journ. Fed. Malay States Mus. **14** (1928) 87–88.

Described from a unique male taken at Cameron's Highlands, Pahang, altitude 4,800 feet, March 13, 1924.

One male, Tjibodas, western Java, altitude 4,200 feet, February 4, 1934 (*M. E. Walsh*); in author's collection.

LECHRIINI

TRICHONEURA (XIPHOLIMNOBIA) JAVANENSIS sp. nov. Plate 1, fig. 12.

General coloration dark brown; head silvery gray; extreme lateral border of præscutum narrowly silvery; pleura with a narrow, pale, longitudinal stripe; legs brown; wings with a strong brown tinge; Rs about one-fifth longer than R.

Female.—Length, about 3.5 millimeters; wing, 3.2.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval to long-oval, with long conspicuous verticils. Head clear silvery gray.

Mesonotum uniformly dark brown, the extreme lateral border of præscutum more silvery. Pleura dark brown, with a poorly defined, pale, longitudinal stripe extending from behind the fore coxæ, across the dorsal sternopleurite, to the abdomen, passing above the fore coxæ. Halteres dusky. Legs with the coxæ and trochanters dark brown; remainder of legs brown. Wings (Plate 1, fig. 12) with a strong brownish tinge; stigma lacking; veins darker brown. Macrotrichia of veins more restricted than in *bontocensis*, there being only two or three at extreme distal end of Rs and none on the main stem of M. Venation: Sc_1 ending about opposite four-fifths the length of Rs, Sc_2 close to its tip; Rs of moderate length, about a fifth longer than R; m-cu a little less than its own length before fork of M_{3+4}.

Abdomen dark brown; valves of ovipositor very long and straight, as in the subgenus.

Habitat.—Java (west).

Holotype, female, Soekaboemi, altitude 1,800 feet, January, 1934 (*M. E. Walsh*); in author's collection.

By my key to the Asiatic species of *Xipholimnobia*[3] the present species runs to *Trichoneura* (*Xipholimnobia*) *bontocensis* Alexander (Luzon), which seems undoubtedly to be its nearest ally. The present species differs in the details of coloration and the more-restricted trichiation of the wing veins.

PEDICIINI

DICRANOTA (RHAPHIDOLABIS) TUBERCULATA sp. nov. Plate 1, fig. 13.

General coloration reddish brown, the præscutum with a single median brown stripe; pleura reddish brown; pronotum with a small median tubercle on the cephalic border; knobs of halteres weakly darkened; wings pale grayish subhyaline, unmarked except for the yellowish brown stigma.

Female.—Length, about 6 millimeters; wing, 5.5.

Described from alcoholic specimens.

Rostrum brown; palpi dark brown. Antennæ black throughout, 13-segmented; flagellar segments oval. Head dark, probably pruinose in fresh specimens.

Pronotum dark brown, with a conspicuous, erect, median tubercle on cephalic border. Mesonotal præscutum gibbous, reddish brown, with a single median brown stripe that becomes obsolete before the suture. Pleura uniformly reddish brown. Halteres pale, the knobs weakly darkened. Legs with the coxæ reddish brown; trochanters paler; remainder of legs broken. Wings (Plate 1, fig. 13) pale grayish subhyaline, unmarked except for the pale yellowish brown stigma; veins pale brown, with abundant macrotrichia. Venation: Rs straighter and somewhat longer than in *consors;* R_{2+3+4} moderately long, subequal to m-cu; R_2 considerably exceeding R_{1+2}; m-cu nearly its own length beyond the fork of M.

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[3] Philip. Journ. Sci. 53 (1934) 440.

Abdomen light brown; valves of ovipositor horn yellow.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Kibune, Kyoto, October 11, 1934 (*Tokunaga*). Paratopotype, female.

The nearest described ally of the present fly is *Dicranota* (*Rhaphidolabis*) *consors* (Alexander), likewise from Japan, which agrees in the nearly immaculate wings with vein R_{2+3+4} preserved, differing in the 12-segmented antennæ, the lack of a pronotal tubercle, and the coloration of the thorax.

DICRANOTA (RHAPHIDOLABIS) BILOBA sp. nov. Plate 1, fig. 14; Plate 2, fig. 31.

General coloration dark gray, the præscutum with three more blackish stripes; pleura heavily gray pruinose; antennæ 15-segmented, black throughout; halteres with darkened knobs; legs black, the femoral bases restrictedly brightened; wings tinged with gray, the prearcular field conspicuously light yellow; stigma and seams along cord and distal half of vein Cu_1 weakly infuscated; R_{2+3+4} longer than basal section of R_5; male hypopygium with the extensive tergite profoundly bilobed by a narrow U-shaped median notch, the lobes with obtuse lateral shoulders before apices.

Male.—Length, about 7 millimeters; wing, 8.5.

Rostrum and palpi black. Antennæ black throughout, 15-segmented, short; flagellar segments beyond the elongate first one oval, becoming smaller and more crowded at outer end. Head dark gray.

Pronotum and mesonotum dark gray, the præscutum with three more blackish stripes, the lateral pair crossing the suture onto the scutal lobes. Pleura heavily gray pruinose. Halteres with stem pale yellow, the knob dark brown. Legs with the coxæ pruinose; trochanters dark brown; remainder of legs long and slender, black, the femoral bases restrictedly paler. Wings (Plate 1, fig. 14) tinged with gray, the prearcular field conspicuously light yellow; costal region less conspicuously brightened; stigma and seams along cord and distal half of vein Cu_1 weakly infuscated; veins brown, yellow in the flavous areas. Venation: R_{2+3+4} from one-half longer to approximately twice the basal section of R_5, the latter subequal to r-m; cell M_1 approximately one-half as deep as cell M_2.

Abdomen black, pruinose. Male hypopygium (Plate 2, fig. 31) with the tergite, *9t*, extensive, the caudal margin profoundly bilobed by a narrow U-shaped notch; lateral margins of lobes before apex with an obtuse lateral shoulder. Outer lobe of basistyle, *b*, relatively slender, with long setæ. Dististyle, *d*, very broadly flattened, extended into a moderately slender beak. Interbase, *i*, deeply bifid before apex, the outer lobe slender, the inner more obtuse, with a lateral flange back from its apex, the margin of lobes microscopically serrulate.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

Dicranota (*Rhaphidolabis*) *biloba* has no close ally among the described regional species of the subgenus. In its general appearance it is most like *D.* (*R.*) *flavibasis* (Alexander), of Japan, which has the wing pattern and venation somewhat similar, but with the details of structure of the male hypopygium entirely different. The profoundly bifid ninth tergite is quite distinct from the condition found in all other species of *Dicranota* known to me.

ULA PROVECTA sp. nov. Plate 1, fig. 15.

General coloration brownish black to black; antennæ elongate; halteres black, the bases restrictedly pale; wings with a strong blackish tinge, the stigma entire, slightly deeper in color; a darkened cloud on r-m; abdomen black.

Female.—Length, about 6 millimeters; wing, 7.4.

Rostrum and palpi black. Antennæ black throughout, relatively elongate for the female sex in this genus; flagellar segments cylindrical; longest verticils subequal to or just exceeding the segments in length; terminal segment a little longer than the penultimate. Head brownish black.

Mesothorax almost uniformly brownish black, without clearly defined markings or pruinosity. Halteres black, the base of stem narrowly paler. Legs with the coxæ and trochanters dark brown; remainder of legs brownish black to black. Wings (Plate 1, fig. 15) with a strong blackish tinge, the stigma and a cloud on r-m deeper in color; stigma uniformly darkened; scarcely evident paler areas at Sc_2, origin of Rs, and outer end of cell 1st M_2; veins brownish black. Macrotrichia lacking in proximal ends of all basal cells (presence of trichia indicated by stipplings in figure). Venation: Rs long, angulated at origin; r-m connecting with Rs immediately before fork; cell 1st M_2 relatively small, shorter than vein M_4 beyond it; m-cu near proximal end of cell 1st M_2, in approximate transverse alignment with r-m.

Abdomen black; valves of ovipositor horn yellow.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

Ula provecta is very distinct from the only other species of the genus so far made known from western China, *Ula comes* Alexander, in the nearly unpatterned wings. It is most generally similar to *Ula fuscistigma* Alexander (Formosa) in its general appearance, differing in the unusually dark ground color of the wings, the position of Sc_2 at about two-thirds the distance between arculus and origin of Rs, and the considerably larger cell 1st M_2.

HEXATOMINI

ADELPHOMYIA MAJUSCULA sp. nov. Plate 1, fig. 16.

Size large (wing, female, 8 millimeters); general coloration of thorax and abdomen black, the præscutum subnitidous; legs yellow, the femoral tips narrowly blackened, the outer tarsal segments black; wings strongly tinged with brown, the stigma darker; trichia of wing cells unusually abundant, occurring in cells Sc_2 to Cu, inclusive; vein R_2 obsolete or virtually so; veins R_3 and R_4 rather strongly divergent; cell M_1 small.

Female.—Length, about 9 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black, the flagellar segments beyond the basal two or three becoming very slender to setaceous, with very long, conspicuous setæ. Head dark brownish gray, somewhat clearer gray on front.

Pronotum black, sparsely pruinose. Mesonotal præscutum black, subnitidous, the posterior sclerites of notum more heavily pruinose. Pleura black, sparsely pruinose. Halteres pale yellow throughout. Legs with the coxæ brownish black, the fore coxæ more intensely darkened; trochanters obscure yellow; femora yellow, the tips narrowly but conspicuously blackened; tibiæ and tarsi brownish yellow, the outer segments of the latter blackened. Wings (Plate 1, fig. 16) with a strong brownish tinge, the stigma darker brown; veins brown, the prearcular and basal veins somewhat more yellowish. Trichia in outer cells of wing unusually abundant and well distributed, involving the outer portions of cells Sc_2 to Cu, inclusive (indicated in figure by stippled dots). Venation: Sc_1 ending a short distance before fork of Rs, Sc_2 some distance from its tip; R_2 obsolete or nearly so, placed at or just beyond fork of vein R_{3+4}, represented by a weak spur on R_3 close to the fork; vein R_{1+2} strongly sinuous upon entering the stigma; veins R_3 and R_4 rather strongly divergent; cell R_3 at margin wider than cell R_2; cell M_1 small; m-cu just before midlength of cell 1st M_2.

Abdomen black throughout, only the cerci horn brown.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, altitude 4,000 feet, October 10 to 24, 1934 (*Graham*).

Adelphomyia majuscula is readily told from the other described Asiatic species by the large size, in conjunction with the abundant macrotrichia of the outer wing cells, the black coloration of the thorax and abdomen, and the unmarked wings, with vein R_2 obsolete or virtually so.

EPIPHRAGMA (EPIPHRAGMA) SUBOBSOLETA sp. nov. Plate 1, fig. 17.

General coloration of præscutum dark brown, the usual stripes confluent, buffy in front, before the suture passing into brown; knobs of halteres with outer portion whitish; legs yellow, the femora with a very narrow, subobsolete brown ring shortly before tip; wings whitish hyaline, with the usual brown pattern of the subgenus, the areas not bordered by darker; outer radial field with pattern paler, more buffy yellow; m-cu at near one-third the length of cell 1st M_2; abdominal tergites dark brown, the sternites obscure yellow.

Female.—Length, 11 to 12 millimeters; wing, 9.5 to 10.

Rostrum and palpi black. Antennæ with scape and pedicel black; basal flagellar segment yellow, the succeeding segments black; flagellar segments cylindrical, with long conspicuous verticils that exceed the segments in length. Head above rich brown, a little brightened on orbits.

Pronotum dark brown. Mesonotal præscutum with the ground color dark brown, the usual stripes confluent, buffy in front, before the suture resolving into four more brownish areas, the intermediate pair separated by a pale line; posterior sclerites of mesonotum chiefly darkened, more or less pruinose. Pleura black, variegated by slightly more pruinose areas. Halteres dusky, the distal half of knob paling to whitish. Legs with the coxæ brownish black; trochanters obscure yellow; femora yellow with a very narrow and indistinct, pale brown ring some distance before apex, in the holotype this ring very faintly to scarcely indicated; remainder of legs yellow, the terminal tarsal segments a trifle darker. Wings (Plate 1, fig. 17) whitish hyaline, with the usual brown pattern, the areas in outer radial field conspicuously paler, more buffy yellow; small darker brown dots at ends of veins R_{1+2}, R_3, and R_4; dark areas not bordered by deeper colors, as in several allied forms; cord and outer end of cell 1st M_2 narrowly seamed with brown; veins brown, somewhat paler in the hyaline areas. Venation: Supernumerary crossvein in cell C transverse in position; basal section of R_5 reduced (as shown) or of normal length; m-cu at near one-third the length of cells 1st M_2.

Abdominal tergites chiefly dark brown; sternites obscure yellow. Valves of ovipositor deep cherry red.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Paratopotype, female.

The only other species of the genus known from western China is *Epiphragma* (*Epiphragma*) *bicinctifera* Alexander, readily told by the two darkened femoral rings. In the combination of body coloration and leg and wing pattern, the present insect similarly differs from all other species hitherto described from eastern Asia.

LIMNOPHILA (ELÆOPHILA) LILLIPUTINA sp. nov. Plate 1, fig. 18; Plate 2, fig. 32.

Size very small (wing, male, less than 4 millimeters); antennal flagellum pale; femora with a brown apical ring; wings broad, whitish subhyaline, heavily patterned with brown, including a series of about six major costal areas; dark dots in interspaces restricted in number, lacking in cephalic portion; male hypopygium with the flange of the outer dististyle subacute; apical spine of style smooth, the margin basad of this point microscopically roughened.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Described from an alcoholic specimen.

Rostrum and palpi dark brown. Antennæ with scape and pedicel dark flagellum yellow, the outer segments a trifle darker; flagellar segments oval. Head dark brown.

Mesonotum chiefly dark brown, in fresh specimens presumably pruinose and more or less patterned. Pleura brown. Halteres pale, the knobs dark brown. Legs with the coxæ and trochanters dark brown; femora yellow, the tips rather broadly and abruptly dark brown, not blackened as in *dietziana;* remainder of legs yellow, the tips of the tibiæ very narrowly darker. Wings (Plate 1, fig. 18) whitish subhyaline, heavily patterned with brown, including a series of about six larger costal areas that are subequal to or narrower than the pale interspaces; dark dots in the pale discal areas restricted in number, lacking in the costal and subcostal fields; band at origin of Rs and along the supernumerary crossvein narrow but complete. Venation as in *dietziana*.

Abdomen dark brown, the incisures somewhat paler. Male hypopygium with the outer dististyle (Plate 2, fig. 32, *od*) having the outer lobe or flange subacute, not rounded at apex as in *dietziana*; apical spine of style slender, smooth, the margin basad of the apex with microscopic spinulæ.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*).

The nearest regional ally of the present fly is *Limnophila* (*Elæophila*) *dietziana* Alexander, which differs especially in the larger size, black femoral apices, more heavily dotted wing pattern, and the details of the male hypopygium, notably the obtuse flange of the outer dististyle, the more strongly curved apical spine, and the entirely smooth margin basad of this point.

LIMNOPHILA (PRIONOLABIS) PILOSULA sp. nov. Plate 1, fig. 19; Plate 2, fig. 33.

General coloration black, sparsely pruinose; antennæ 16-segmented, black throughout; halteres unusually elongate, whitish, the knobs weakly darkened; legs brownish black to black; wings broad, whitish subhyaline, the stigma and a restricted cloud on anterior cord pale brown; numerous coarse macrotrichia in cells of wing beyond cord; cell M_1 present; m-cu lying far distad, at or beyond three-fourths the length of cell 1st M_2; male hypopygium with the outer dististyle bearing a single, slender, erect spine before the curved, acute, terminal spine; inner dististyle terminating in a simple yellow blade.

Male.—Length, 8 to 10.5 millimeters; wing, 10 to 13.5.

Rostrum and palpi black. Antennæ 16-segmented, black throughout; flagellar segments oval, becoming smaller outwardly, the terminal segment exceeding the penultimate. Head dull black; anterior vertex wide.

Thorax almost uniformly dull black, the surface very sparsely pruinose. Halteres of unusual length, whitish, the knobs weakly darkened. Legs with coxæ and trochanters black; remainder of legs brownish black to black, moderately hairy. Wings (Plate 1, fig. 19) broad, whitish subhyaline, the stigma and a restricted cloud on anterior cord pale brown; veins brown. Conspicuous coarse macrotrichia in cells of wing beyond cord (in figure represented by stippled dots). Venation: Sc_1 ending shortly before fork of R_{2+3+4}, Sc_2 nearly opposite the fork of Rs; R_2 faint, subequal to R_{1+2}; cell M_1 present; m-cu lying far distad, at near three-fourths to four-fifths the length of cell 1st M_2.

Abdomen, including hypopygium, black, sparsely pruinose. Male hypopygium (Plate 2, fig. 33) with the median region of tergite, *9t*, gently emarginate, the lateral portions of the notch a trifle produced. Outer dististyle, *od*, with the basal half swollen and provided with elongate setæ, the distal portion narrowed to an acute, gently curved spine, with a smaller, more slender denticle back from tip; inner dististyle, *id*, a simple yellow blade. Ædeagus, *a*, and gonapophyses, *g*, both appearing as compressed yellow blades, as shown, the latter wider than in most other species of the subgenus.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*). Paratopotypes, 12 males.

The present fly is amply distinct from the remaining score of species of the subgenus in the pilosity of the outer cells of the wing. In its size and general appearance it is most like such a species as *Limnophila* (*Prionolabis*) *rufipennis* Alexander, of Japan, yet is very distinct. The subgenus had not been recorded previously from China.

ERIOPTERINI

GONOMYIA (GONOMYIA) LUTEIPLEURA sp. nov. Plate 1, fig. 20.

General coloration yellow, the præscutum and scutum conspicuously patterned with dark brown; thoracic pleura immaculate yellow or virtually so; wings strongly tinged with yellow, the stigma vaguely darkened; Sc short, Sc_1 ending exactly opposite origin of Rs; cell 1st M_2 open by atrophy of m; abdominal tergites dark brown medially.

Female.—Length, about 5 millimeters; wing, 5.

Described from an alcoholic specimen.

Rostrum and palpi obscure yellow. Antennæ moderately elongate, pale brown; flagellar segments passing through oval, elongate-oval to linear. Head light brown.

Thorax yellow, the præscutum with three conspicuous dark brown stripes that are subconfluent, the median stripe narrowly split at cephalic end; scutal lobes chiefly darkened, the posterior fourth of each yellow; median area of scutum and the scutellum yellow; mediotergite weakly darkened. Pleura, including pleurotergite, yellow, without clearly defined darkenings. Halteres elongate, pale. Legs with the coxæ and trochanters yellow; remainder of legs brownish yellow, the terminal tarsal segments darker. Wings (Plate 1, fig. 20) strongly tinged with yellow, the stigmal region vaguely darkened; veins brownish yellow. Venation: Sc short, Sc_1 ending exactly opposite origin of Rs, Sc_2 not clearly evident in the type but presumably at the extreme tip of Sc_1; r-m at fork of Rs; R_{2+3+4} elongate, approximately five-sixths Rs; cell 1st M_2 open by the atrophy of m; m-cu shortly beyond fork of M.

Abdomen with the tergites dark brown medially, pale yellow laterally; sternites yellow.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

The nearest described ally is *Gonomyia* (*Gonomyia*) *gilvipennis* Alexander, which differs especially in the pattern of the thorax and in the venation, as the elongate Sc, which ends at or beyond one-third the length of Rs. The open cell 1st M_2 in the present species may be an abnormality of the unique type, but certainly appears to represent a normal condition, being virtually the same on both wings. If the cell is normally closed it would, be of unusual length, since vein M_{3+4} is longer than M_1.

TRENTEPOHLIA (MONGOMA) PLATYLEUCA sp. nov. Plate 1, fig. 21.

Allied to *tenera;* head dark brown; mesonotal præscutum almost uniformly dark brown or brownish black; scutellum and mediotergite obscure yellow; pleura chiefly yellow; femora dark brown throughout, tibiæ paling to yellowish white on distal half; tarsi yellowish white; a series of about ten small erect spines at base of femur; wings grayish subhyaline; inner end of cell M_3 lying far proximad of other outer cells.

Female.—Length, about 9.5 millimeters; wing, 7.6.

Rostrum brownish yellow; labial palpi pale; maxillary palpi with outer segment darkened. Antennæ with scape brown; pedicel and flagellum black; flagellar segments long-oval, with scattered setæ of moderate length. Head dark brown; anterior vertex reduced to a linear strip.

Pronotum dark brown above, narrowly yellow laterally. Mesonotal præscutum almost uniformly dark brown or brownish black; median region of scutum obscure yellow, the lobes darkened; scutellum and mediotergite obscure yellow. Pleura with the dorsopleural region, propleura, and anepisternum darkened, the remaining pleura and pleurotergite yellow. Halteres dusky, the base of stem restrictedly pale. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow; femora dark brown throughout; tibiæ with about the basal half pale brown, the distal portion passing into yellowish white; tarsi yellowish white; a series of about ten small erect spines at base of each femur. Wings (Plate 1, fig. 21) grayish subhyaline, cells C and Sc a trifle darker in color; stigma narrow, darker brown; veins brown. Venation: Rs of moderate length, about a third longer than the basal section of R_5; R_5 a little shorter than the cephalic face of cell 1st M_2 ($R_5 + M_{1+2}$); inner end of cell M_3 lying far proximad of other cells; m-cu very close to fork of M; apical fusion of Cu_1 and 1st A slight; cell 2d A relatively wide.

Abdomen with the tergites brown, the basal sternites light yellow, the outer ones more infuscated. Ovipositor with valves horn-colored.

Habitat.—Formosa.

Holotype, female, Kuraru, August 12, 1934 (*Gressitt*); in author's collection.

Despite the uniformly darkened femora, I regard the present fly as being most nearly allied to *Trentepohlia* (*Mongoma*) *tenera* (Osten Sacken), of the Philippine Islands. By Edwards's arrangement of the Oriental species of *Mongoma*,[4] the fly traces to *pallidiventris* Brunetti, *pallidipes* Edwards, and other forms, differing in the pattern of the body and legs. By my key to the Philippine species of the genus,[5] the fly runs to *T.* (*M.*) *alboterminalis* Alexander, a very different fly. There is no very closely allied species hitherto made known from China, Japan, or Formosa.

ORMOSIA BIANNULATA sp. nov. **Plate 1, fig. 22; Plate 2, fig. 34.**

Mesonotum brownish gray, the posterior sclerites and pleura brownish black, more or less pruinose; femora black, paler basally, with two narrow yellow rings, the apical one narrower; tibiæ and tarsi black; wings pale brown, conspicuously variegated by whitened areas, including a series in outer ends of the cells before the margin; R_2 a short distance before the fork of R_{3+4}; veins R_3 and R_4 upcurved at outer ends; male hypopygium with the outer dististyle a slender curved spine, the basal portion more dilated; inner style shorter, unequally bidentate at apex; gonapophysis blackened, flat, the apex bispinous, the upper and lower margins with appressed serrations.

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[4] Journ. Fed. Malay States Mus. 14 (1928) 110–111.

[5] Philip. Journ. Sci. 53 (1934) 442–444.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black throughout, of moderate length, if bent backward extending to beyond the wing root; flagellar segments long-oval, with long, secund setæ on the more basal segments. Head brownish gray.

Mesonotum brownish gray, injured in the type, the præscutum apparently without stripes. Pleura and posterior sclerites of notum brownish black, more or less pruinose. Halteres pale, the base of knob a trifle darker. Legs with the coxæ brownish black; trochanters brownish yellow; femora black, narrowly yellowish at base; a narrow yellow ring at near two-thirds the length, together with the apex narrowly of the same color; tibiæ and tarsi black. Wings (Plate 1, fig. 22) pale brownish, conspicuously variegated by clearer whitened areas, distributed as follows: In cell R, before and beyond origin of Rs; most of cell R_1 and adjoining portion of Sc_1; conspicuous white spots in outer ends of cells R_2, R_3, R_4, R_5, 1st M_2, 2d M_2, M_4, and 1st A; basal portion of cell 1st A similarly whitened; stigmal area slightly darker brown; veins and trichia of the darkened areas of the cells deeper brown. Venation: R_2 a short distance before the fork of R_{3+4} the tips of the latter veins gently upcurved; inner end of cell 1st M_2 truncate; m-cu sinuous, before the fork of M; vein 2d A strongly sinuous.

Abdomen, including the hypopygium, brownish black. Male hypopygium (Plate 2, fig. 34) with the tergite, *9t*, broad. Basistyle, *b*, with the apical margin produced into a flattened glabrous lobe, its apex obtusely rounded. Two dististyles, *d*, one a slender curved spine from a more dilated basal portion, the second shorter, unequally bidentate at apex. Gonapophyses, *g*, appearing as blackened flat blades, terminating in two major acute spines, with additional appressed serrations on both the upper and lower margins of the structure. Ædeagus, *a*, slender.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, altitude 4,000 feet, October 10 to 24, 1934 (*Graham*).

The nearest ally of the present fly is *Ormosia pulchra* (Brunetti), of the western Himalayas, which differs especially in the details of coloration of the body and in the pattern of the wings. The male sex of the latter species is still unknown.

ERIOPTERA (ERIOPTERA) ALBOGUTTATA DAISENICA subsp. nov. Plate 2, fig. 35.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Generally similar to *Erioptera* (*Erioptera*) *alboguttata* Edwards (Formosa), differing especially in hypopygial characters. Wings somewhat broader, with the white spots smaller and more clearly delimited; white band at cord disconnected from the area on Sc; spots in outer radial field much smaller than the interspaces.

Male hypopygium (Plate 2, fig. 35) with the distal portion of the inner dististyle, *id*, more slender than in the typical form, the long pale setæ at the bend of the style exceeding in length the apical spine beyond the point of their insertion. Outer gonapophyses, *og*, short and broad, more or less boomerang-shaped, the setæ restricted to outer half; apical blackened spine short and cultriform.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

ERIOPTERA (CHEILOTRICHIA) LÆTIPENNIS sp. nov. Plate 1, fig. 23; Plate 2, fig. 36.

General coloration pale yellow to brownish yellow; antennal flagellum yellow; tips of femora narrowly darkened; tibiæ conspicuously ringed with brownish black and yellow, clothed with elongate setæ; wings pale yellow, sparsely variegated by brown dots on the crossveins and deflections, and by a more extensive dusky cloud at wing apex; veins R_{2+3+4} and R_{3+4} subequal in length; male hypopygium with dististyles and gonapophyses entirely pale; outer dististyle a simple sinuous rod.

Male.—Length, about 2.5 millimeters; wing, 2.6.

Female.—Length, about 2.8 millimeters; wing, 2.9 to 3.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ with scape and pedicel brown; flagellum yellow.

Mesonotal præscutum almost uniformly yellow, the posterior sclerites slightly darker. Pleura yellow, the sternopleurite a little darker. Halteres pale yellow. Legs with the coxæ and trochanters yellow; legs chiefly detached, conspicuously hairy; a middle leg still in position is colored as follows: Femur yellow, the tips narrowly darkened; tibia brown at both ends, the slightly more extensive central portion yellowish white; basal two tarsal segments whitish, the terminal three segments darker; setæ of tibia longer and darker in color on the infuscated portions than on the pale central area. Other detached legs show the femora chiefly darkened, with a narrow pale ring before outer end; a further leg, apparently representing the posterior pair, has the entire basal three-fourths of the tibia yellow, the distal fourth darkened, the vestiture conforming in color to the region where borne, the setæ of the apical fourth long and conspicuous. Wings (Plate 1, fig. 23) pale yellow, sparsely variegated by dark dots on many of the crossveins and deflections, and by a more extensive pale brown wash in outer ends of outer radial and medial fields, involving cells R_4 to 2d M_2, inclusive; dark seams and dots distributed as follows: At arculus, origin of Rs, Sc_2, along all elements of the cord and outer end of cell 1st M_2, R_2, and as smaller marginal dots at ends of all longitudinal veins; veins pale yellow, a little darkened in the clouded areas. Venation: Sc_2 at extreme tip of Sc_1; R_{2+3+4} subequal to R_{3+4}, R_2 being at near midlength of the anterior branch of Rs; veins R_3 and R_4 relatively long and lying generally parallel to one another; cell 1st M_2 closed; m-cu erect, more than one-half its length before the fork of M; anal veins divergent.

Abdomen pale brownish yellow. Male hypopygium (Plate 2, fig. 36) with apex of basistyle produced into a pale lobe. Both dististyles entirely pale, the outer, *od*, a long, sinuous, simple, acicular rod that gradually narrows to an acute point. Inner dististyle, *id*, bifid, entirely pale. Gonapophyses, *g*, entirely pale, appearing as two, slender, submedian rods, lying generally parallel to one another, and with smaller, lateral, spiniform blades.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*). Allotopotype, female. Paratopotype, female.

Erioptera (*Cheilotrichia*) *lætipennis* is very different from the only other member of the subgenus in eastern Asia, *E.* (*C.*) *imbuta* Wiedemann, in the variegated wings, patterned tibiæ, and very different structure of the male hypopygium. The latter species likewise occurs in Japan and its hypopygium is shown for comparison (Plate 2, fig. 37). Note especially the entirely pale, expanded outer dististyle, *od*, with a stout marginal spine on basal half; bifid inner dististyle, *id*, with the outer arm blackened and bidentate at apex; conspicuously blackened gonapophyses, *g*, the outer pair spinose on distal half, the inner pair with weaker spinulæ before the apex.

Whether the groups *Cheilotrichia* Rossi (1848) and *Empeda* Osten Sacken (1869) can be maintained as distinct is becoming very questionable in my mind. Almost the only character still available for defining the two groups is found in the extreme distal position of vein Sc$_2$, which lies at or very close to the extreme tip of Sc$_1$ in *Cheilotrichia*. In *Empeda* this element is slightly removed from the tip of Sc$_1$ while yet lying far more distad than in the remaining subgeneric divisions of *Erioptera*.

MOLOPHILUS POLYCANTHUS sp. nov. Plate 1, fig. 24; Plate 2, fig. 38.

Belongs to the *gracilis* group and subgroup; general coloration brown; antennæ short in both sexes; male hypopygium with two slender pale spines on either side, additional to the blackened dististyles, the inner one of the latter with the distal third set with abundant microscopic spines.

Male.—Length, about 3.5 millimeters; wing, 3.5.

Female.—Length, about 4.5 millimeters; wing, 4.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ short, if bent backward ending about opposite the wing root, pale brown throughout. Head brown.

Thorax almost uniformly brown, without evident markings (in spirit). Halteres white. Legs with the coxæ and trochanters brownish yellow; femora obscure yellow, the tips weakly darkened; remainder of legs yellow, the terminal tarsal segments darker. Wings (Plate 1, fig. 24) tinged with yellow or brownish yellow; veins pale brown. Venation: R$_2$ lying slightly distad of r-m; vein 2d A nearly straight, ending about opposite m-cu.

Abdomen brown, the hypopygium a trifle paler, yellowish brown. Male hypopygium (Plate 2, fig. 38) with the inner dististyle, *id*, the longest element, its distal third armed with numerous small suberect spines. Outer dististyle, *od*, a smooth, sinuous blackened horn. Ventral lobe of basistyle, *vb*, long and conspicuous. Two very long, slender, pale spines apparently arise from the distal end of the basistyle, one close to the base of the ventral lobe, the other much more distad, possibly arising from the dorsal lobe of the style, but this not clear in the slide mount. Phallosomic plate oval in outline.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*). Allotopotype, female. Paratopotypes, 1 male, 1 female.

Molophilus polycanthus is very distinct from other regional species of the genus in the structure of the male hypopygium. The forms that are most similar are *M. ferox* Alexander, *M. takaoensis* Alexander, and *M. triacanthus* Alexander, all differing notably in the details of hypopygial structure.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *ig*, inner gonapophysis; *od*, outer dististyle; *og*, outer gonapophysis; *s*, sternite; *t*, tergite; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tanyptera cognata* sp. nov., venation.
2. *Pselliophora stabilis* sp. nov., venation.
3. *Pselliophora lauta* sp. nov., venation.
4. *Dictenidia luteicostalis* sp. nov., venation.
5. *Tipula* (*Oreomyza*) *cladomera* sp. nov., venation.
6. *Limonia* (*Limonia*) *arthritica* sp. nov., venation.
7. *Limonia* (*Dicranomyia*) *penita* sp. nov., venation.
8. *Limonia* (*Rhipidia*) *isospilota* sp. nov., venation.
9. *Limonia* (*Rhipidia*) *hypomelania* sp. nov., venation.
10. *Antocha* (*Antocha*) *spicata* sp. nov., venation.
11. *Orimarga* (*Orimarga*) *distalis* sp. nov., venation.
12. *Trichoneura* (*Xipholimnobia*) *javanensis* sp. nov., venation.
13. *Dicranota* (*Rhaphidolabis*) *tuberculata* sp. nov., venation.
14. *Dicranota* (*Rhaphidolabis*) *biloba* sp. nov., venation.
15. *Ula provecta* sp. nov., venation.
16. *Adelphomyia majuscula* sp. nov., venation.
17. *Epiphragma* (*Epiphragma*) *subobsoleta* sp. nov., venation.
18. *Limnophila* (*Elæophila*) *lilliputina* sp. nov., venation.
19. *Limnophila* (*Prionolabis*) *pilosula* sp. nov., venation.
20. *Gonomyia* (*Gonomyia*) *luteipleura* sp. nov., venation.
21. *Trentepohlia* (*Mongoma*) *platyleuca* sp. nov., venation.
22. *Ormosia biannulata* sp. nov., venation.
23. *Erioptera* (*Cheilotrichia*) *lætipennis* sp. nov., venation.
24. *Molophilus polycanthus* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Oreomyza*) *cladomera* sp. nov., male hypopygium, lateral aspect.
26. *Tipula* (*Oreomyza*) *cladomera* sp. nov., male hypopygium, details.
27. *Limonia* (*Dicranomyia*) *penita* sp. nov., male hypopygium.
28. *Limonia* (*Rhipidia*) *hypomelania* sp. nov., male hypopygium.
29. *Antocha* (*Antocha*) *spicata* sp. nov., male hypopygium.
30. *Orimarga* (*Orimarga*) *distalis* sp. nov., male hypopygium.
31. *Dicranota* (*Rhaphidolabis*) *biloba* sp. nov., male hypopygium.
32. *Limnophila* (*Elæophila*) *lilliputina* sp. nov., male hypopygium, outer dististyle.
33. *Limnophila* (*Prionolabis*) *pilosula* sp. nov., male hypopygium.
34. *Ormosia biannulata* sp. nov., male hypopygium.
35. *Erioptera* (*Erioptera*) *alboguttata daisenica* subsp. nov., male hypopygium.
36. *Erioptera* (*Cheilotrichia*) *lætipennis* sp. nov., male hypopygium.
37. *Erioptera* (*Cheilotrichia*) *imbuta* Wiedemann, male hypopygium.
38. *Molophilus polycanthus* sp. nov., male hypopygium.

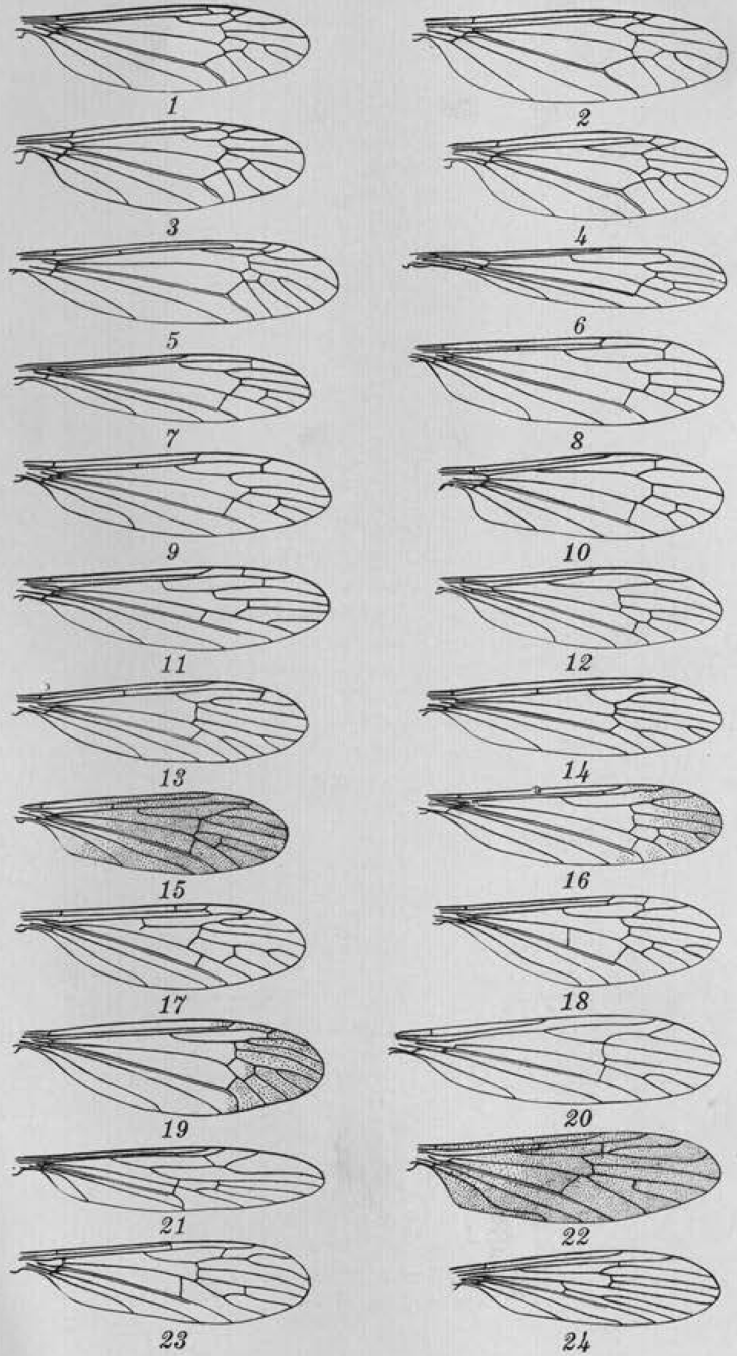
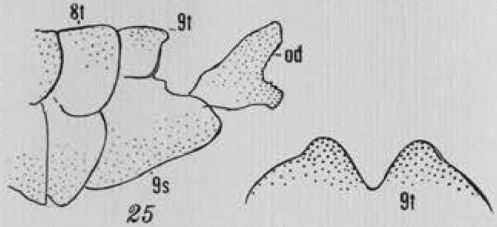


PLATE 1.



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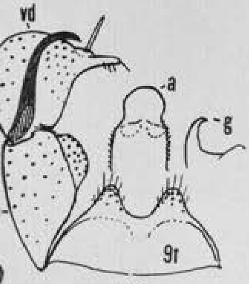

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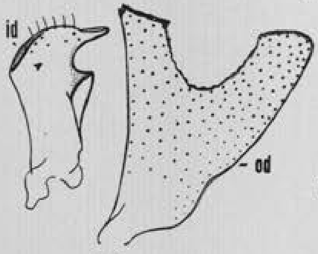

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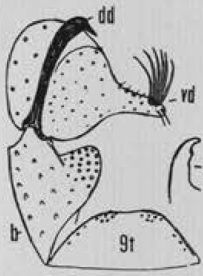

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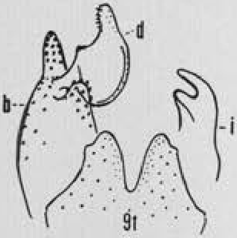

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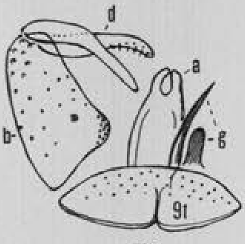

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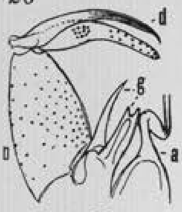

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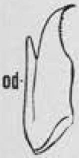

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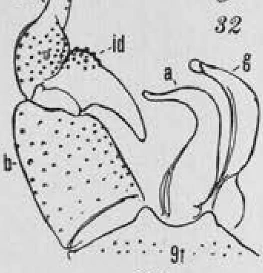

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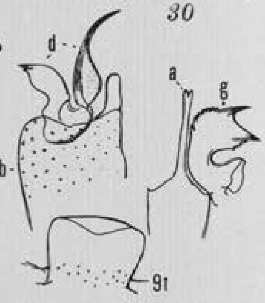

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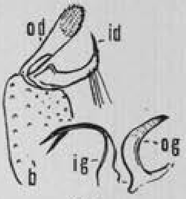

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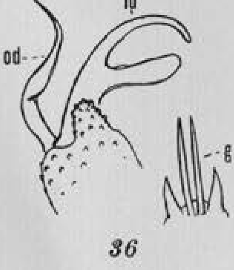

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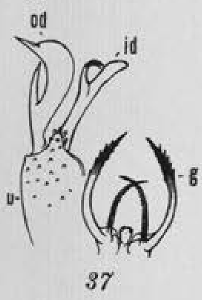

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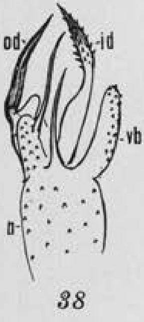

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PLATE 2.

THE MULLET FISHERY OF NAUJAN, MINDORO

ITS EFFECT ON THE SEX RATIO OF THE SPAWNING MULLET MUGIL DUSSUMIERI CUVIER AND VALENCIENNES

By HILARIO A. ROXAS and SANTOS B. RASALAN
Of the Bureau of Science, Manila

THREE TEXT FIGURES

In a survey of the fisheries of Naujan Lake, Mindoro Island, Herre (1927) found that the ecological conditions obtaining in the lake are exceedingly favorable to the rapid growth and development of mullets. It is, therefore, quite natural to find that nearly all people inhabiting the northern portion of Mindoro as well as those of Batangas and Cavite Provinces and Manila, Luzon, depend on this lake and its outlet, Butas River, for their mullet supply.

Naujan Lake (fig. 1) is a medium-sized, shallow lake situated in the northeastern part of Mindoro. It is approximately 14 kilometers long and 8 kilometers wide, its longer dimension extending in a north-and-south direction. It is mostly 3 to 4 meters in depth, although at places a depth of from 10 to 12 meters is reached. It receives its water supply from numerous small streams and creeks originating in the surrounding plains and hills, mostly from the western and southern sides. Its only outlet is Butas River, which runs a coarse of approximately 6.5 kilometers in a north-northwest direction. At its end it is met by Pinagsabañgan River, the two forming Lumangbayan River, which runs in a northeast direction and empties into the sea. The village of Lumangbayan lies on the beach northward from the mouth of the river. The Butas-Lumangbayan River system is one of the largest river systems in northern Mindoro and forms the dividing line between the lowland on the western side and the mountainous district on the eastern side.

Since 1908 the municipal council of Naujan, Mindoro Province, has awarded, for the purpose of raising revenue, the exclusive rights to exploit the fish resources of the lake and the Butas-Lumangbayan River system to the highest bidder. For the proper conservation of the mullet fishery, ordinances have

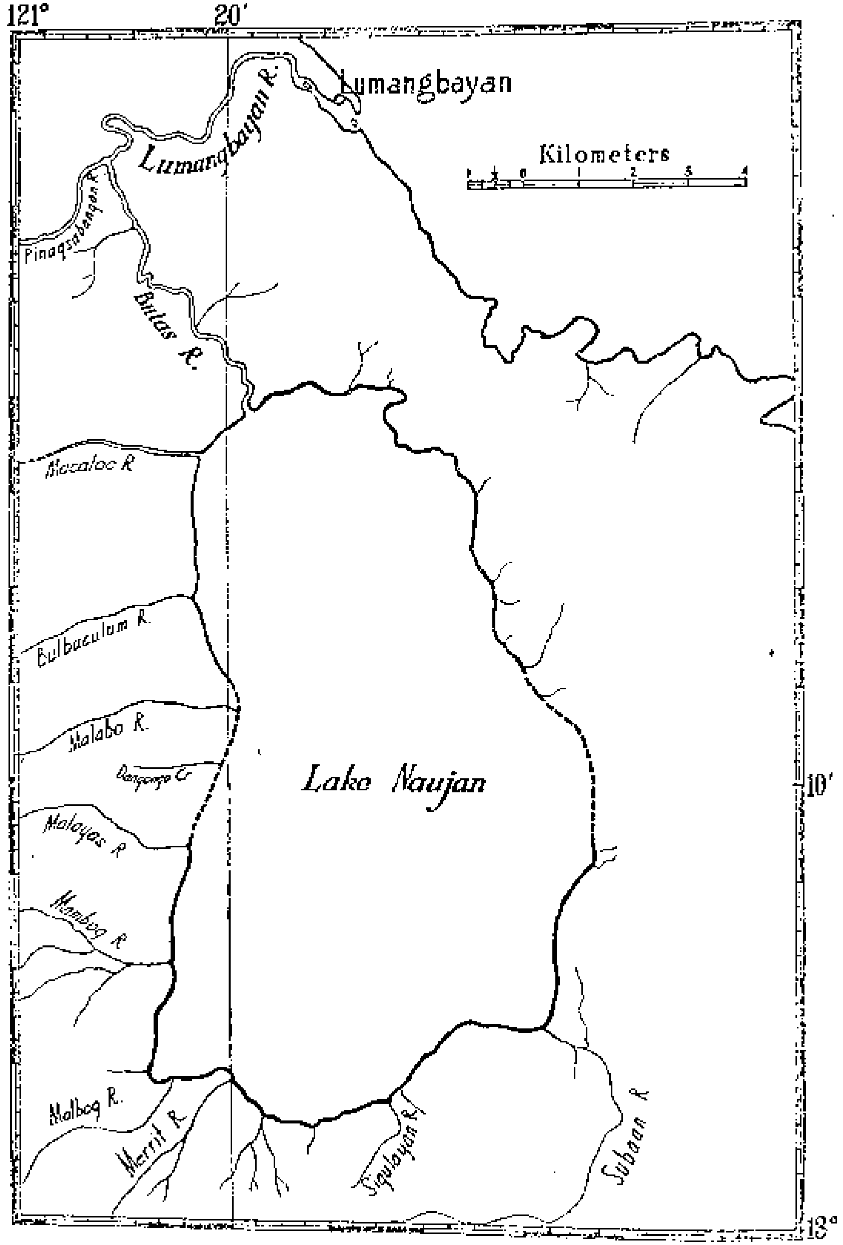

FIG. 1. Naujan Lake, Mindoro.

been passed, establishing a closed season for the catching of mullets. In the beginning the closed season was from October 1 to December 31, inclusive, of each year, but later it was changed to a 30-day period from January 15 to February 15, inclusive. October 15, 1934, the closed season was again changed to the entire month of January of each year. The terms of the award require the lease holder to keep the fish corral situated at Butas River open during the closed season so as to allow the mullets to reach the sea in their seaward migration. During the closed season it is also prohibited to catch mullets in any portion of Lake Naujan, in Butas and Lumangbayan Rivers, and in the municipal waters along the sea adjacent to the mouth of Butas River. Notwithstanding the above-mentioned regulations, which have been in force for over twenty-six years, the inhabitants of Naujan and adjacent places claim that there has been a notable decrease in the mullet catch from year to year. Although this claim cannot be supported by statistical data due to lack of catch records of the various gear used in the region during the past years, the claim that there is a decline in the returns of fishery enterprises in this locality may be taken as an indication that the stability of the fishery is being threatened. Therefore, the condition of the fisheries deserves immediate consideration.

In order to solve the problem of the mullet-fishery conservation, the biology of the mullet, particularly the factors that affect its life history in its up-and-down-stream migration, and the effectiveness of the fishing devices used for catching it were studied. These studies should be continued and the results critically analyzed if satisfactory regulations to prevent the gradual depletion or total destruction of this important fishery are to be promulgated.

Despite the fact that mullets are valuable food fishes, widely distributed in both tropical and temperate waters, nothing is known about the sex ratio of the species under consideration. Investigations and surveys were made by Garrow (1874), Hoxie (1884), Earl (1889), Kishinouye (1898), and Goode (1892), but they were confined to the various experiences of the fishermen and to accounts of fish-culture methods in other countries. Stearns (1879), Dannevig (1902), Roule (1915), Roughley (1916), and Higgins (1924) worked on the habits, migration, racial localization, rate of growth, and size at sexual maturity.

The typical sex ratio of one to one in sexually reproducing organisms seems to be inapplicable to teleostean fishes. Even if we disregard the result of differential migration or death rate during any stage of development, the fact remains that the male is usually smaller and more agile than the female (Geiser, 1924) and, therefore, has a greater chance to escape. Working on several fishes belonging to the family Pœcilidæ and basing their conclusions on either cytological studies of embryos or examination of adults collected in the field, Hildebrand (1917), Smith (1912), Eigenmann (1904, 1912), Henn (1916), and others found that females greatly predominate over males. Eigenmann (1896), working on *Cymatogaster*, and Hubbs (1921), working on *Amphigonoptera*, found that the ratio is almost one to one. In spawning California barracudas (*Sphyræna argentea*), Wilford (1931) found that there is a very slight preponderance of the males. In true smelts Kendal (1926) found the males predominating, while in jack smelts (Clark, 1929), California sardines (Clark, 1925), and the European plaice (Hefford, 1909) the females were more abundant than the males.

This paper sets forth the effect of the Butas *baclad* on the sex ratio of spawning mullets (*Mugil dussumieri* Cuvier and Valenciennes). This species forms the bulk of the catch of this fish corral as well as of other gear in extensive use during the period of investigation, which covered four months, from November, 1934, to March, 1935. This period practically coincides with the entire mullet season, the peak of which is from November to December. The investigation was undertaken to find out if the fish corral situated about 5 kilometers from the lake from where the fish are migrating and where enormous numbers of mullets are being caught, disturbs the sex ratio of the spawners in their breeding ground in the sea. The investigation also shows how much chance either sex has of reaching the sea to spawn as well as the effect of the late closed season that has been observed for the last twenty-six years.

THE BUTAS BACLAD

The Butas baclad is located in Butas River just above its junction with Pinagsabangan River. It existed as early as 1908. The period of its lease ranged from four to five years. Under this arrangement, the lease holder has the sole right to catch fish in the lake and Butas River, permitting no other parties to take advantage of the aquatic resources of these municipal waters. Table 3 shows the amounts for which the Naujan fisheries have been leased since 1908.

The fish corral (fig. 2) has always been of the *bunuhan* type, consisting of two diagonally placed wings (*a*) converging towards the middle of the stream and inclosing a V-shaped area,

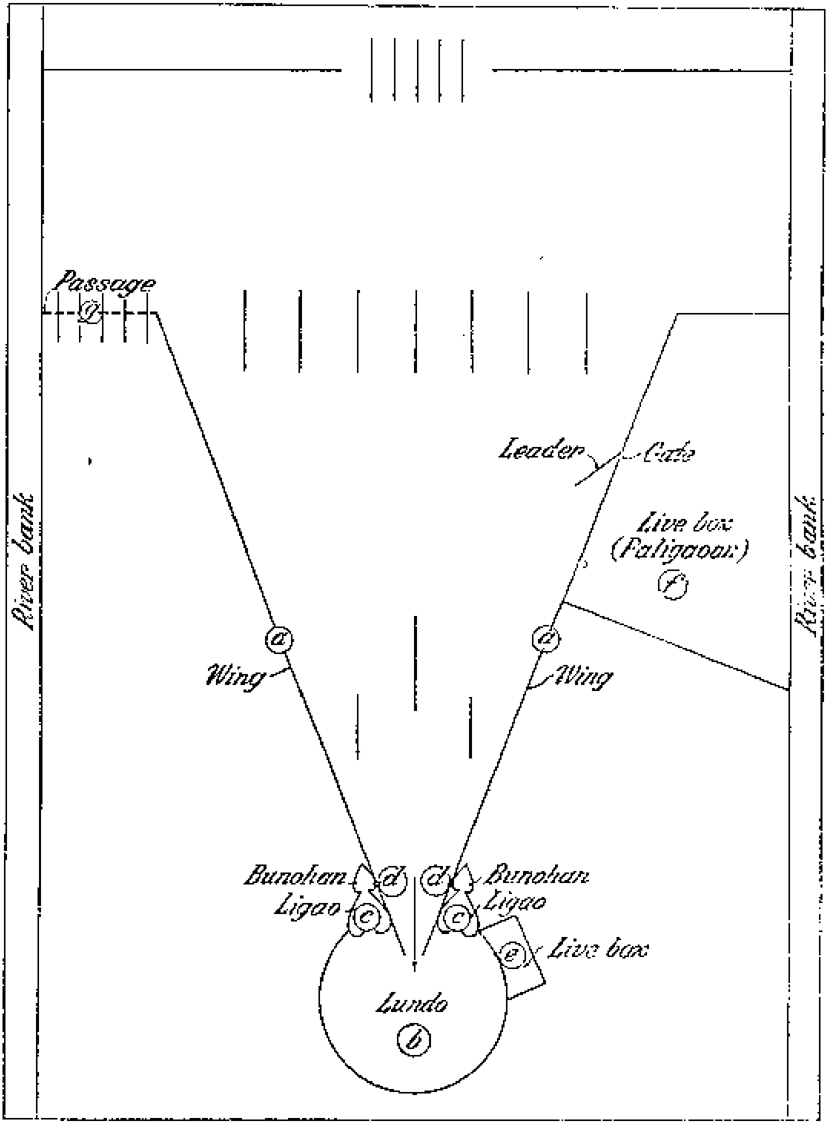

FIG. 2. The Butas baclad in Butas River, Mindoro.

a semicircular inclosure, the *lundo* (*b*), with first and second pairs of heart-shaped inclosures called *ligao* (*c*) and bunuhan (*d*) on each end; and one or two live boxes (*e* and *f*) on one side. The wings cover about three-fourths of the width of the river, leaving a passage (*g*) on one side of the river for bancas to go through. This passage is barred, however, by a dam of bamboo stakes and poles which does not reach the surface of the water. Palm leaves laid across the clear surface serve to frighten the fish away from this open space so that few, if any, attempt to pass here. Ten meters above the corral a fence made of bamboo screen with an opening at the middle is located. This opening as well as the passage (*g*) is first temporarily blocked by bamboo screens or nets before the river is seined to drive the fish into the corral. The fishes are caught at the bunuhan (*d*).

SAMPLING

Samples were collected at very irregular intervals, depending upon the availability of materials, during any one haul of the dip net in the Butas baclad (fish corral) and of the *pukot* (drag seine) at Lumangbayan. During stormy weather, when the pukot could not be used at the latter place, the catch of the *cayod* or *tigpao* (dip net) and *dala* (cast net) were used. Throughout the period of investigation no immature mullets were caught by the above-mentioned gear.

The determination of sex was based on the following sexual dimorphism: Because of much enlarged ovaries, the belly of the female is more angular and much broader than that of the male. In the female a more or less well-developed oviducal aperture, which serves as a passage for the eggs to the outside, is present behind the vent. The urethral aperture is not distinct in the male. Upon pressure, droplets of creamy milt are extruded from the belly of the male, and eggs from the belly of the female. The female is larger than the male. A sexually mature female *banak* has a standard length of from 24 to 36 centimeters; the male, from 19 to 27 centimeters. In water the female is sluggish while the male is active and fast.

RESULTS

Table 1 shows the proportion of males to females as counted from various hauls of the dip net in Butas baclad from November 19 to 27, 1934, from January 23 to 30, from February 1 to 26, and from March 4 to 23, 1935. It can be seen that during

TABLE 1.—*The proportion of male to female mullets at Butas baclad.*

Date.	Total.	Males.	Females.	Ratio of males to females.
1934		*Per cent.*	*Per cent.*	
November 19	60	7	93	1:14
November 23	32	6	94	1:15
November 24	41	2	98	1:40
November 25	63	5	95	1:20
November 27	45	11	89	1:8
Total	241	6	94	1:15
1935				
January 23	26	35	65	1:2
January 24	30	34	66	1:2
January 25	28	21	79	1:4
January 26	34	12	88	1:8
January 27	44	5	95	1:21
January 28	26	3	97	1:25
January 30	50	10	90	1:9
Total	238	16	84	1:7
February 1	50	20	80	1:4
February 3	68	12	88	2:15
February 7	32	6	94	1:16
February 10	11	1	99	1:10
February 14	24	17	83	1:5
February 18	41	15	85	1:6
February 26	31	10	90	1:9
Total	267	17	83	1:7
March 4	60	34	66	1:2
March 6	40	37	63	3:5
March 7	30	34	66	1:2
March 10	35	29	71	2:5
March 15	60	42	58	5:6
March 18	38	47	53	9:10
March 22	60	50	50	1:1
March 23	16	50	50	1:1
Total	339	40	60	1:1.4

all this period there is a great preponderance of females over males in the mullets caught in the fish corral. November 19, 1934, for example, of the 60 mullets caught, only 7 per cent were males, while 93 per cent were females, a ratio of 1 to 14. An equally great preponderance of females over males was observed November 23, 24, and 25, 1934; January 27 and 28, 1935; and February 7, 10, and 26, 1935. In general during the early part of the mullet season the preponderance of females over males was great, and gradually diminished towards the end of the season, when a ratio of almost 1 to 1 was reached.

In November, 1934, for example, of the 241 mullets examined, 94 per cent were females and only 6 per cent males, whereas in March, 1935, of 339 fish examined 60 per cent were females and 40 per cent males. During the last two days of observation, that is March 22 and 23, a ratio of 1 to 1 was observed in 16 mullets examined.

Covering the same period, but on different dates, sex counts were also made on spawning mullets in the sea from hauls of drag seines, dip nets, and cast nets in the neighborhood of Lumangbayan. The result of this count is shown in Table 2. No-

TABLE 2.—*The proportion of male to female mullets at San Jose No. 2 (Lumangbayan).*

Date.	Total.	Males.	Females.	Ratio of males to females.
1934		*Per cent*	*Per cent.*	
November 16	63	95	5	20:1
November 17	65	96	4	26:1
November 21	32	91	9	16:1
November 22	4	100	0	4:0
November 25	18	94	6	17:1
November 26	3	100	0	3:0
November 27	2	100	0	2:0
Total	177	95	5	17:1
December 4	60	10	90	1:9
December 6	52	4	96	1:25
December 7	63	2	98	1:20
December 8	60	3	97	1:29
December 9	42	5	95	1:20
December 10	37	13	87	1:6
December 12	41	2	98	1:40
December 14	52	4	96	1:26
December 18	47	2	98	1:46
Total	454	6	95	1:18
1935				
January 22	30	34	66	1:2
January 23	50	40	60	2:3
January 24	40	75	25	3:1
January 29	75	60	40	3:2
Total	195	54	46	7:6
February 12	24	83	17	5:1
February 13	57	88	12	7:1
February 17	4	100	0	4:0
Total	85	87	13	7:1
March 5	12	100	0	12:0
March 12	0	0	0	0
March 19	0	0	0	0

vember 16, 1934, of the 63 mullets examined, 95 per cent were males, and only 5 per cent were females. During the latter half of November, 1934, there was a great preponderance of males over females. In January, February, and March, 1935, there was also a preponderance of males over females when of 292 mullets examined there was a ratio of almost 4 to 1.

TABLE 3.—*Lease of the Naujan fisheries.*

Period of lease.	Years.	Amount.	Yearly rate.
		Pesos.	*Pesos.*
1908-1911	4	1,236.00	309.00
1912-1916	5	7,500.00	1,500.00
1917-1920	4	10,000.00	2,500.00
1921-1924	4	14,000.00	3,600.00
1925-1929	5	26,250.00	5,250.00
1930-1934	5	40,000.00	8,100.00
1935-1939	5	55,965.00	11,193.00

This condition, however, did not obtain during December when of 454 fishes examined only 5 per cent were males, while 95 per cent were females, or a ratio of 1 to 19. This is explained by the fact that November 28, 1934, a strong typhoon visited the northern part of Mindoro, causing the swelling of the water in Lake Naujan and Butas River. This inundation resulted in the total destruction of the Butas baclad, which was not repaired till about the middle of January, 1935. During December, therefore, when the Butas baclad was out of commission, the mullets from the lake migrated unmolested towards the sea. Fishing activities of Lumangbayan were also suspended for five days because of strong gales and high waves. When fishing was resumed, hundreds of mullets were caught daily by means of drag seines (cayod), and cast nets (dala). It was during this period that the females outnumbered the males at Lumangbayan. For example, December 4, 1934, of the 60 mullets examined only 2 were males, the rest were females, and December 18 the ratio of males to females was 1 to 46.

DISCUSSION

Text fig. 3 shows graphically the relation of the abundance of males and females at different months of the mullet season. Broken lines represent the percentage of males to all fishes, while the solid lines represent the percentage of females to all fishes. *A* shows the relative abundance of males and females at Lumangbayan, the spawning ground. At this place, except during the period between December 4 and January 18 when the fish corral was out of commission, there is an abundance of males and a scarcity of females. *B* is for Butas baclad, above which is the feeding ground. During the early part of the mullet season at this place there is a high percentage of females and a very low percentage of males. This high percentage of females continues to the middle of February and gradually diminishes towards the end of March. The number of males also continues small to the second week of February and gradually goes up towards March when a ratio of 1 to 1 is reached.

As a result of the presence of the Butas baclad, which catches a large number of sexually mature mullets, the sex ratio of the mullets at their breeding ground is disturbed. In their seaward migration from their feeding ground there is less escape of sexually mature females through the fish corral. They are so heavily laden with eggs and thus sluggish in their movements that they can neither pass through the slats of the fish corral nor jump over the barricade placed across the passage (fig. 2, *g*). The males, on the other hand, have a much greater chance of escaping through the Butas baclad and, therefore, have a much greater chance of reaching the spawning ground.

We presume that during the early and middle part of the mullet season there is a predominance of females over males, although systematic data are lacking. This assumption is based on the incident that during the first half of December, when the mullets were left unmolested as a result of the destruction of the Butas baclad, there was a preponderance of females over males even in the spawning ground. In their breeding ground, however, the males not only predominate over the females but also there is a scarcity of females. This condition is not conducive to proper and adequate formation of larval fishes.

The placing of the closed season for the catching of mullets at such a late period as January or from January 15 to February 16 is defective in the sense that only a very small number of female mullets reach the sea during this period. Thus, the purpose behind the establishment of a closed season is defeated by placing it towards or at the end of the mullet season. Such a late closed season does not permit a sufficient number of egg-

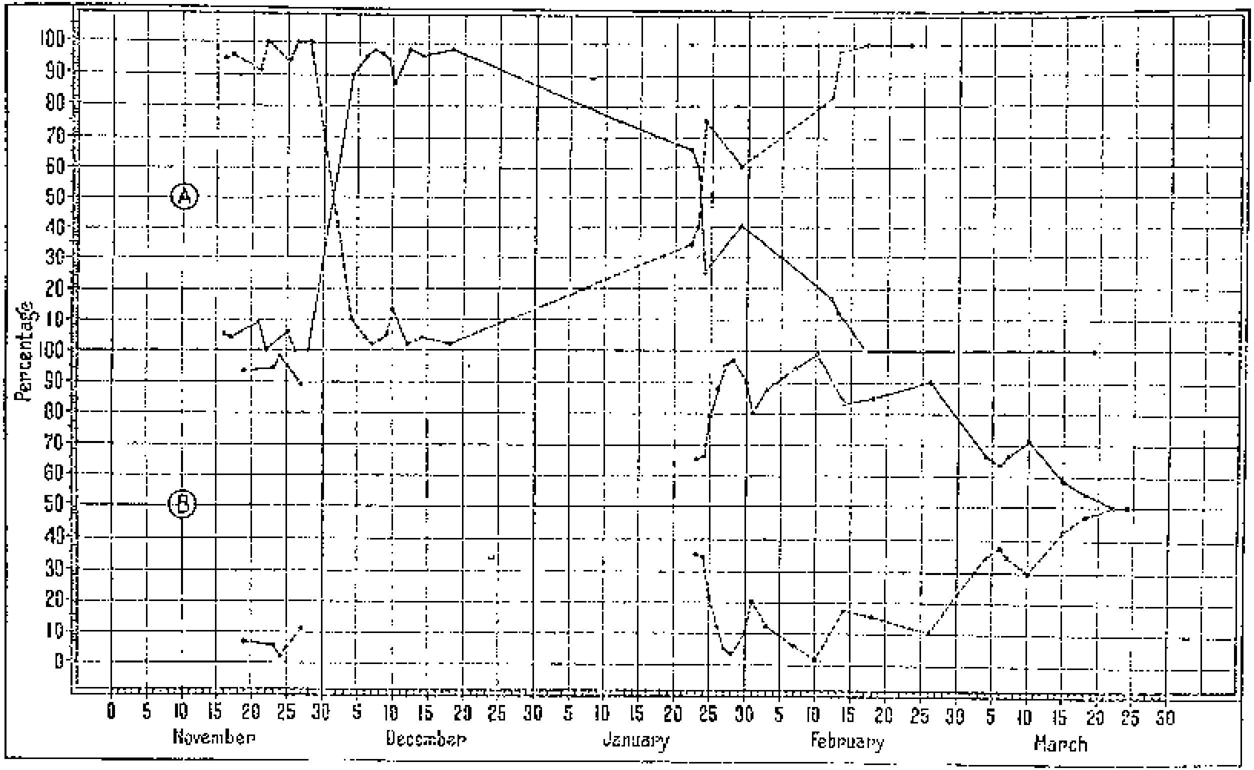

FIG. 8. The relative abundance of male and female mullets in various months of the mullet season. Broken lines represent the percentage of males to all fishes; solid lines represent the percentage of females to all fishes.

laying mullets, which will give rise to fry and fingerlings, to reach the sea.

While it is true that a small portion of Butas River is left open for the passage of bancas during the open season, this passage is nevertheless so treated that it does not allow a normal and sufficient number of egg-laying mullets to escape towards the sea. This condition is best seen during the latter part of November, the latter half of February, and the early part of March, periods of open season, when few or no females are caught on the spawning ground.

Other survey work carried on in Laguna de Bay, Taal Lake, and Naujan Lake showed that the peak of the downward migration of sexually mature mullets is from November 15 to December 15 of each year. This finding was the basis of the provisions of Fish and Game Administrative Order No. 3, which took effect June 16, 1935. This order makes it unlawful during the closed season from November 15 to December 15, inclusive, of each year for any person, association, or corporation to catch or cause to be caught, sell, offer or expose for sale any spawning mullet. Spawning mullets, which may be included with other kinds of fish in a haul or catch, should be immediately set free unhurt. The same administrative order totally prohibits at all times the catching of mullet fry and fingerlings. Besides giving adequate protection to mullets, which carry ripe eggs and milt during their seaward migration, mullet fry and fingerlings should be given every chance to reach their feeding ground, where they attain a marketable size and sexual maturity. The spaces between the slats of fish corrals, partly or totally damming a river, should be made wide enough to allow an unimpeded upward migration of young mullets throughout the year.

SUMMARY AND RECOMMENDATION

1. The mullet season in Naujan Lake and vicinity is from November to March, inclusive, of each year.

2. On the basis of the fishes caught and examined, there appears to be a greater number of females during the early part of this season. Towards the end of the season the preponderance of the females diminishes due to the fact that much fewer females are able to escape.

3. The Butas baclad situated near the outlet of Naujan Lake, Mindoro, caught more sexually mature females than males during the period of investigation.

4. As a result, only few female spawners reach the breeding ground, a fact that, perhaps, partly explains the supposed gradual but continuous decrease in the volume of the mullet catch in Naujan Lake and vicinity from year to year.

5. The placing of the closed season towards the end of the mullet season is defective. Although mullets are left unmolested during this period, only very few sexually mature females reach the sea to spawn.

6. The closed season for mullets should be placed at the early part of the season, if possible, from November 15 to December 16, or better still, from November 1 to December 15 of each year.

7. If this is not possible, the passage (*g*) should be left entirely open and unbarricaded during the entire mullet season and should only be closed temporarily when the river above the fish corral is seined to drive the mullets towards the inclosure.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Naujan Lake, Mindoro.

2. The Butas baclad in Butas River, Mindoro.

3. The relative abundance of male and female mullets in various months of the mullet season. Broken lines represent the percentage of males to all fishes; solid lines represent the percentage of females to all fishes.

FISHES IN THE ZOÖLOGICAL MUSEUM OF STANFORD UNIVERSITY, III

NEW GENERA AND SPECIES OF GOBIES AND BLENNIES AND A NEW MYXUS, FROM THE PELEW ISLANDS AND CELEBES

By ALBERT W. C. T. HERRE
Of Stanford University, California

ONE PLATE

The author spent the month of October, 1933, and part of November, in the Mariana and Caroline Islands, twenty-three days being spent in the Pelew Islands. These islands lie about 750 miles due east of Davao, Mindanao, and are the western outpost of the Caroline Islands. The Pelew group is about 135 miles in length, and about 15 miles in breadth. The rainfall averages 165 inches a year, but there are no fresh-water streams of any consequence, nor could there be in islands of such character. The large island of Bab-el-Thuap has a few permanent streams, but the fresh-water fauna is very limited.

The shore fishes of the Pelew Islands are, in the main, an extension of the fish fauna of the Philippines, Celebes, and the north coast of Dutch New Guinea. They are, therefore, of considerable interest to the student of Philippine fishes, since they throw additional light upon the distribution of fishes in the western Pacific. I have recently published elsewhere a check list of fishes of the Pelew Islands. The present paper describes the new species secured by me and is a continuation of the series on noteworthy fishes in the Stanford University collection.

ELEOTRIDÆ

Genus LIZETTEA novum

The body is thick, robust, wedge-shaped, with a very large, broad, depressed head, projecting lower jaw, and very deep caudal peduncle. There are about 55 ctenoid scales in a longitudinal, 20 in a transverse series, the teeth of the scales very numerous and exceedingly short. There are about 36 cycloid scales before the first dorsal, extending forward to the interorbital groove. The snout, lips, underside of the head, and membranous flap of the opercle are naked, the body otherwise is completely scaled; smaller scales cover the bases of the pectoral and caudal fins, the fins otherwise free of scales.

Broad bands, composed of lines of minute foliose papillæ, mark the head elaborately, as follows: One encircling each eye and its adjacent nostrils, the two rings connected by a broad curved band on the interorbital groove; from the lower and posterior sides of this orbital ring 3 more or less branched bands extend across the preopercle; from behind the eye another broad band extends above the preopercle and opercle to a point above the gill opening; from the upper portion of the preopercular margin a band extends downward and curves forward along the underside of the lower jaw to meet its fellow at the symphysis; on the opercle is a narrow vertical stripe posteriorly and 3 transverse lines of papillæ. There are no large pores on the snout or along the margins of the opercle and preopercle.

There are 8 or 10 rows of minute teeth in the upper jaw, those of the innermost row slightly enlarged and depressible; they form a broad band anteriorly, which becomes much narrower posteriorly. In the lower jaw there are 8 rows anteriorly, which dwindle to 3 or 4 rows posteriorly.

First dorsal IV (V ?); second dorsal I, 7; the first dorsal is noticeably low, the dorsals close together; anal I, 7. The second dorsal and anal are short but high. The pectoral, caudal, and ventrals are all pointed.

The anterior nostril is tubulate, the posterior one not. The wide gill openings extend forward beneath the posterior part of the preopercle, the isthmus moderately broad. Branchiostegals 5.

This genus is very close to *Bunaka* Herre, but differs in the dorsal and anal formulæ, the character of the bands of sensory papillæ on the head, the shape of the caudal and pectoral fins, the dentition, and the scalation of the head.

In fresh water. Type of the genus, *Lizettea pelewensis*.

The name is derived from the Christian name of my wife.

LIZETTEA PELEWENSIS sp. nov. Plate 1, fig. 1.

The first dorsal has but 4 spines, but at some distance behind the second spine there is a bony tubercle which probably represents the basal portion of an undeveloped third spine. The second dorsal and anal each I, 7. There are 54 or 55 scales in a longitudinal series, plus about 12 more on the caudal base, and 20 in a transverse series from the origin of the second dorsal to that of the anal; there are about 36 scales before the first dorsal, the snout beyond the middle of the interorbital being naked.

The wedge-shaped body is thick and bulky, with the dorsal outline forming a low arch; the broad head is depressed, the mouth very wide with projecting lower jaw, the cheeks plump.

The width of the head equals the greatest depth of the body, 3.77 times in the length; the head is 2.8 times, the bluntly pointed caudal a shade less than 3 times in the length. The broad interorbital equals the low depressed snout, 4.87 times, the prominent eye 5.5 times in the head; the mouth is oblique, its cleft opposite the lower margin of the eye, the maxillary extending to a point beneath the hind margin of the pupil, and 2.7 times in the head; the top of the snout has a large low hump. The tubulate anterior nostril is very near the margin of the snout; the posterior nostril is above the front margin of the eye; there are no visible pores beside the nostrils or on the margins of the opercle, preopercle, or elsewhere on the head. The least depth of the conspicuously deep caudal peduncle is 2.33 times in the head, 1.45 times in the body depth, and is seven-eighths of its own length.

The dorsals are close together, separated by only two scales; the first dorsal is noticeably low, the second spine highest and 3.9 times in the head or 2.9 times in the depth, the length of the fin base twice in the head; the second dorsal and anal are short but high, the fifth ray in each highest and equal to the depth opposite its base, neither fin reaching the caudal base when depressed; the fifth ray of the second dorsal is 1.8 times in the head, 1.35 times in the depth, the length of the second dorsal base 2.5 times in the head; the fifth anal ray is 1.7 times in the head; 1.26 times in the depth, the length of the anal base 3 times in the head; the large pointed pectoral extends to a line vertical from the anus and equals the depth of the body, 1.34 times in the head; the pointed ventral falls much short of reaching the anus, 1.44 times in the head. The anal papilla is a large, thick, broadly ovate, leaflike organ which extends upon the base of the anal spine.

The color in alcohol is black above and on the sides, each lateral scale with a paler brown margin; underneath the color becomes dusky warm reddish brown, each scale on the breast and belly with a darker spot, these spots forming rows; the lower portion of the opercle and preopercle and underside of the head are flecked with whitish spots and very short bars; the first dorsal is very dark purplish with black spots; the second dorsal, caudal, and anal are purplish or plum black, the anal with a few pale spots basally; the scaled portion of the pectoral is black, the rest of the fin black with crossbars of pale spots; the ventrals are blackish plum color with whitish crossbars and spots on the basal half.

The type and only specimen, a female 219 mm long, measures 294 mm from the tip of the lower jaw to the tip of the tail. It was taken from a fresh-water brook on a small islet in the Pelew Islands.

GOBIIDÆ

Genus MACRODONTOGOBIUS novum

This genus has the general aspect of *Gnatholepis*, but differs in having two enormous solid incisors side by side on the vomer, extending clear across the roof of the mouth. The entire body except the snout, lips, and underside of the head is covered with large ctenoid scales except before the ventrals, where the scales are cycloid. There are 26 scales in a longitudinal series.

The dorsals are rather low, VI–I, 9; anal I, 9; the rounded caudal and pointed pectoral equal the head; the frenum of the elongate ventral is thin and weak.

The large eyes are very close together and shorter than the prominent snout; the anterior nostril has a very thin-walled tubule, the posterior nostril not tubulate; the small mouth is oblique, with four rows of fine teeth in the upper jaw; the lower jaw has an inner band of four rows of fine teeth and a short outer row of enlarged teeth ending in a small posterior canine laterally. The tip of the tongue is rounded. There are no mucus canals or rows of sensory papillæ on the head.

The gill openings are restricted, scarcely wider than the pectoral base, the isthmus broad; there are no fleshy flaps on the shoulder girdle and no free silky rays on the pectoral.

This genus differs markedly from the other genera thus far known to possess vomerine teeth, *Mars* Jordan and Seale, *Smilogobius* Herre, and *Myersina* Herre, which are all more or less naked anteriorly, and with 50 or more scales in the longitudinal series.

MACRODONTOGOBIUS WILBURI sp. nov. Plate 1, fig. 2.

Dorsal VI-I, 9; anal I, 9; there are 26 scales in a longitudinal, plus 3 more on the caudal base, and 8 in a transverse series; there are 6 predorsal scales, which extend to the eyes, and 3 rows of large scales on the preopercle.

The depth of the elongate, subcylindrical body is 4.7 to 4.8 times, the head 3.6 to 3.7 times in the length; the dorsal profile is greatly convex, the ventral profile nearly horizontal; the head is bluntly rounded, the jaws equal; the protuberant snout is 3.25 times in the head; the large conspicuous eyes are laterodorsal in position, seven-eighths as long as the snout, 3.7 times in the head, and very close together; the interorbital is of negligible breadth, about 9 times in the eye; the mouth is oblique, the maxillary reaching a vertical from the front margin of the pupil, 2.7 times in the head; the very small teeth are in bands of 4 rows each in both jaws; in the lower jaw there is also a short outer row of larger and more widely spaced teeth, ending posteriorly in a small canine on each side; the cheeks are covered with large scales. The depth of the caudal peduncle is 1.8 times in its own length and 2.6 times in the head.

The first dorsal is of moderate height, the tips of the spines more or less threadlike, 1.6 to 1.44 times in the head; the second dorsal is low to medium height, 1.35 to 1.8 times in the head, the anal 1.3 to 1.6 times; both the second dorsal and the anal may almost reach the caudal base when depressed or may fall considerably short of reaching it; the pectoral extends to a vertical from the base of the first ray of the second dorsal and the anal origin, and equals the head; the elongate ventral reaches beyond the anus or the anal fin, and is a little shorter than the head; the narrow round-pointed caudal equals the head; the anal papilla is short, slender, and pointed in males; in females it is short, thick, and nearly cylindrical.

The color in alcohol is whitish gray, much flecked with dusky above and on the sides, and with five large dusky spots along the sides at the level of the pectoral base, the last one on the caudal base; there are traces of four dorsal crossbands; below the eye is a large dark brown or blackish spot extending downward across the cheek; a similar or even larger spot is on the opercle; a diagonal dark brown bar extends downward and forward from the eye across the snout, upper, and lower lips, ending in a spot beneath; the snout and other parts of the head are flecked with dusky spots and short bars; the dorsals, caudal, and pectoral are crossbarred by rows of dark brown or dusky spots; the anal and ventrals are dusky; the eyes are black with iridescent pupils of metallic green, purplish bronze, and red.

Here described from the type, 47 mm long, and 3 paratypes 48, 50, and 42 mm in length, collected on Gorror Reef, Pelew Islands.

I take pleasure in naming this species after Dr. Ray Lyman Wilbur, whose support made it possible for me to visit the Pelews.

VAIMOSA BORIÆ sp. nov.

Dorsal VI–I, 7 or 8; anal I, 6 or 7; there are 24 or 25 scales in a longitudinal series, plus 1, 2, or 3 on the caudal base, and 7 in a transverse series; there are 7 predorsal scales and 5, rarely 6, large opercular scales.

The types are a male 29 mm long and a female 27.5 mm long. The male is big headed with a slenderer body, the female with a smaller head and a much deeper and more robust trunk. Where two measurements are given that of the male is first. The depth is 4.8 to 4.6 times, the head 2.9 to 3.4 times in the length; the rounded caudal equals the head; the pectoral is 4.1 to 4.6 times, the ventral 4.1 to 5, the first dorsal spine 3.6 to 6, the longest second dorsal ray 3.6 to 5.5, the longest anal ray 4.1 to 6.8 times in the length. In the male the last dorsal and anal rays are much the longest, extending upon the caudal when depressed. In the female the third or fourth ray is longest.

The eye is 4 times, the snout 3.6, the interorbital 10 to 8, the least depth of the caudal peduncle 3 to 2.5 times in the head.

The body is thick and robust anteriorly, the dorsal profile nearly horizontal, the ventral profile moderately convex; the broad snout is convex, the mouth oblique, the jaws equal; in the male the maxillary extends beyond the posterior margin of the eye and in the female beneath the posterior part of the pupil. The large ctenoid scales extend forward to the eyes, which are dorsolateral and very close together. On the cheeks, opercles, and nape are rows of sensory papillæ. On the opercle one row describes a complete circle around the central scale. In the females the dorsals and anal are of only moderate height and the second dorsal and anal fall far short of the caudal when depressed.

Paratypes have the depth 4.5 to 5 times, the head 3.1 to 3.6, the caudal 4 to 4.1, the pectoral 4.5 to 5, the ventral 4.4 to 4.6, the first dorsal 4.4 to 4.7, the second dorsal 5.2 to 5.3, the anal 5.5 to 6.5 times in the length; the eye is 3.5 to 3.8 times, the snout 3.5, the least depth of the caudal peduncle 2.4 to 2.65 times in the head.

The snout is usually a little more or less than the eye. The maxillary usually extends to a vertical from the middle of the eye, but in some does not reach so far.

In males the first dorsal spine is more or less elongated, with filiform tip; rarely 3 or 4 spines may have threadlike elongated tips. One male has the first dorsal spine extending beyond the anal, 1.85 times in the total length.

The color in alcohol is more or less brownish or blackish brown above, becoming gray or whitish on the sides and underneath. There are five or six dusky crossbands on the back, two before the first dorsal, one beneath each dorsal fin, and two on the caudal peduncle, which continue down the sides and unite with a row of brown or blackish spots along the middle of the side. In the male type the lateral spots have united to form a longitudinal band. In most specimens the crossbands below the dorsals continue down the sides to the belly, and may unite with the one from the opposite side. There are two black spots on the caudal base, with a clear spot between them. There are two black spots under the anal and two on the underside of the caudal peduncle. Two dusky bars extend from the eye across the mouth to the lower jaw, and other blackish brown bars and spots extend across the cheeks, opercle, and pectoral base. The first dorsal has a conspicuous black basal spot between the fifth and sixth spines, the rest of its base more or less brown, the remainder of the fin clear with a black margin above. The second dorsal is clear with three irregular crossbands of blackish brown; the caudal is clear with five crossrows of blackish spots; the anal and ventrals have blackish rays with clear membrane or may be largely blackish; the pectoral is clear.

Here described from the types and ten paratypes, 21 to 29 mm in length. They were taken from a fresh-water creek on Bab-el-Thuap, the main island of the Pelew Islands, by Mr. Y. Hori, after whom I take pleasure in naming this interesting little fish. Mr. Hori is the scientific expert of the Pelew Fishery Experiment Station.

STIPHODON PELEWENSIS sp. nov.

Dorsal VI–I, 9; anal I, 10; there are 36 scales in a longitudinal series to the upper angle of the pectoral base, and 2 more small scales on the caudal base, 12 predorsal, and 9 in a transverse series.

The depth of the slender body is 7.6 times, the head a trifle over 4 times, and the broadly rounded caudal 3.8 times in the length; the short blunt snout slopes steeply to its tip which projects over the upper lip and is contained 4 times in the head; the interorbital equals the eye, which is very high up, lateral, 3.4 times in the head; the least depth of the caudal peduncle is 2.16 times in the head and 1.66 times in its own length.

The mouth is small, the posterior angle of the maxillary beneath the front edge of the pupil; the teeth are typical of the genus. The predorsal scales are cycloid and smaller than the ctenoid scales on the rest of the body.

The dorsals and anal are low, the first dorsal not reaching the second when depressed, and the second dorsal and anal falling far short of reaching the caudal; the first dorsal spine is 1.6 times in the head; the highest second dorsal and anal rays equal the depth; the pointed pectoral extends to a vertical from the anus, 4.4 times in the length; the ventral is an almost circular disk, 6.6 times in the length or 1.6 times in the head.

The color in alcohol is nearly white, with a broad black band below the first dorsal, another from the second dorsal to the anal; the top, snout, and sides of the head black, and the caudal black with a narrow white upper and lower margin; a blackish brown stripe extends from behind the eye to below the second dorsal and a smaller one from the eye to the dorsal origin; the dorsals and anal are margined in front with white, the remainder black; the pectoral base is black, the fin colorless with crossbars of blackish dots; the central portion of the ventrals is black, the remainder colorless. A blackish brown stripe on the middle of the side connects the black crossbands; it is most evident above the anal and before the caudal blotch.

Here described from the type and only specimen, 26.5 mm long, or 33.5 mm including the caudal, taken on the reef at Gorror, one of the Pelew Islands.

BLENNIDÆ

Genus LEMBEICHTHYS novum

Dorsal 68–70; anal 50–55.

The body is elongate, tapering, naked, with the caudal separate from the dorsal and anal; the dorsal is of flexible spines, its origin over the opercle; the origin of the anal is in the anterior portion of the body, the length of the anal more than twice that of the head and trunk together; the ventrals are very small, of two rays, inserted beneath the hind margin of the opercle, distinctly in advance of the pectoral. The head is deeper and broader than the body, without tentacles or barbels, the snout blunt, the mouth inferior; the teeth are in one row, fixed, different in the two jaws, those of the lower jaw with arrowlike tips; there is a large pair of posterior canines in the lower jaw, as in *Petroscirtes*. The gill opening is restricted to a small opening above the upper angle of the pectoral base. Branchiostegals apparently 5.

Type species, *Lembeichthys celebesensis* sp. nov.

Named from the type locality, Lembeh Strait, Celebes.

From *Pholidichthys* Bleeker, to which it is closely related, it differs in the dentition, and in having the caudal fin entirely free from the other fins.

LEMBEICHTHYS CELEBESENSIS sp. nov. Plate 1, fig. 3.

Dorsal 68–70; anal 50–55; caudal with 11 rays plus 2 accessory rays on both the upper and lower margins.

The depth is 15.7 times, the head 7.85 to 8.46 times, the caudal 11 times, the pectoral 12.2 to 12.5 times in the length; the head and trunk together are 2.4 to 2.9 times in the tail, which is 70 to 74.5 per cent of the total.

The head is broader and deeper than the trunk or tail, with a broad, blunt, projecting snout; the eye is 3.33 to 3.6 times, the snout 4.1 to 5.4 times in the head; the interorbital equals the eye; the mouth is inferior and rather large, extending beneath the anterior portion of the pupil; there are 20 or 22 flat incisorlike teeth in the upper jaw, the end tooth on each side pointed and a little larger than the others; there are 22 teeth in the lower jaw, their tips shaped like arrowheads; the two large curved canines equal the diameter of the pupil in length.

The first few dorsal spines are low, those following are highest, 2⅓ in the head, but most of the fin is of nearly uniform height with the anal, 3.5 times in the head. The pectoral is pointed; the caudal of one specimen was forked but has been damaged; the other was nearly truncate; the minute ventral is 7 times in the head.

The color in alcohol is pale tan, the lower half sprinkled with reddish brown specks, and with more or less silvery sheen on the sides of the head, trunk, tail, and yellow belly; there are five dark brown spots on the dorsal region beneath the dorsal, the first above the anal origin; the snout is dusky and the area between the eyes and dorsal origin is dark brown. The dorsal and anal are pinkish brown, densely dotted with dark brown specks, and with a black margin. The caudal has a large red-brown basal spot, the rest of the fin white; the pectorals and ventrals are also white.

Here described from the type and paratype, both 55 mm in length, collected at Lembeh Strait, Celebes. The type is much bulkier than the paratype and has a longer head and trunk.

CIRRIPECTES CANINUS *sp. nov.*

Dorsal XII, 12; anal 15; ventral 3; pectoral 15. The head equals the depth, 3.28 times in the length; the caudal is 4.6 times, the pectoral 2.875 times in the length; the eye is 2.9 times, the snout and interorbital each 3.5 times in the head; the depth of the caudal peduncle equals the eye; the ventral is 1.75 times in the head.

The compressed ovate body is deepest just behind the pectoral base; the caudal peduncle is entirely free, its length a trifle more than its depth. The greatest width of head equals that of the body, 1.63 times in the head. The dorsal profile of the head descends in a nearly straight angle of 45° from above the middle of the eye to the tip of the snout. The mouth is small, oblique, the posterior angle of the maxillary beneath the front margin of the eye. The lower jaw has four large hooked canines near the symphysis, with a single row of very small teeth behind them; the upper jaw has four similar but much smaller canines, with a short row of fine teeth behind.

On the nape is a row of 26 tentacles, some of them broad and bifid; the anterior nostril has a short broad fringed tentacle; there is no orbital tentacle, no papillæ or tentacles on the lips or chin. The gill opening is nearly vertical and narrower than the pectoral base. The short lateral line extends to a point above the middle of the pectoral. The dorsal begins above the hind margin of the preopercle, the second dorsal midway between the hind margin of the eye and the caudal base; the first dorsal is broken, but the height is about 1.75 times in the head; the second dorsal is highest anteriorly, the first ray 2.33 times in the head. The anal origin is midway between the front margin of the eye and the caudal base, its height equal to that of the soft dorsal; the pectoral extends to a point above the fourth anal ray; the caudal is rounded, its central rays longest.

The color in alcohol is yellow with large brown spots between the pectoral and dorsal, and similar but much smaller spots covering the entire head and pectoral base; the dorsal has 10 blackish brown spots or vertical bands; the pectoral is brown spotted, with black tips; the other fins are colorless.

Described from the type and only specimen, caught by electric light, at Ternate, one of the Moluccas.

PETROSCIRTES GORRORENSIS sp. nov.

Dorsal 40; anal 24; pectoral 14; caudal 11, plus an accessory ray on the upper and lower margins.

The depth is 7.2 to 7.3 times, the head 4 to 4.1 times, the caudal 6.5 to 7 times in the length. The snout, interorbital, and eye are approximately equal, 3.8 to 3.9 times in the head; the curved mouth is of moderate size, not reaching the eye; there are 10 or 12 teeth on each side of the upper jaw, with a small posterior canine; the large curved canine of the lower jaw equals the pupil.

The elongate slender body tapers gradually from above the pectoral origin to the caudal base; the least depth of the caudal peduncle is 3.66 to 3.4 times in the head; the head is elongate, conical, pointed, without tentacles or barbels, the gently convex snout projecting slightly beyond the mouth. The low dorsal begins above the posterior margin of the preopercle, and is highest in the posterior half, its height 2.4 to 2.5 times in the head; the anal is a little lower, 3 to 3.16 times in the head; the bluntly rounded pectoral is 1.9 to 2 times in the head; the ventral is 2.7 times in the head.

The color in alcohol is brown with a white stripe (blue in life) from the eye to the pectoral base and continuing onto the base of the caudal; at right angles to the white stripe are ten white vertical bars, the first behind the pectoral, the last at the posterior end of the dorsal; these bars extend from the top of the dorsal to the longitudinal stripe and on below it a slight distance but diagonally backward; the dorsal has a fine white marginal line and a narrow white submarginal stripe; the anal is dark brown on the outer half, much paler basally; the caudal and pectoral are colorless, the ventrals colorless or faintly brown.

Described from the type, 44 mm long, from the reefs surrounding Gorror, one of the Pelew Islands, and a paratype 39 mm long from Madang, on the north coast of New Guinea.

This species is close to *Petroscirtes rhinorhynchus* Bleeker, but differs in fin rays, dentition, and color markings.

MUGILIDÆ

MYXUS MALAYANUS sp. nov.

Dorsal IV–I, 8; anal III, 9; the scales are very deciduous, their number uncertain, 34 to 38 longitudinally, 12 transversely, 20 or 21 before the first dorsal.

The type, 35 mm long, and a paratype 34 mm long, have the depth 3.8 to 3.9, the head 3.67 to 3.77, the caudal 4.35, the pectoral 5.8, the ventral 7 times in the length; the eye is 3, the snout 3.15, the least depth of the caudal peduncle 2 times in the head. The first and second dorsal and anal are approximately equal in height, 8.75 times in the length.

The body is much compressed, deep, the dorsal profile convex from the dorsal origin to the snout tip; the first dorsal origin is a trifle nearer the caudal base than the tip of the snout and beneath the first anal ray. The preorbital is serrated on its anterior margin, and more finely serrate on its lower truncate border; the protractile mouth is nearly vertical, with thin lips and a single symphysial knob; there is a single row of teeth in the upper jaw and a few teeth in the lower jaw near the symphysis; the vomer has a patch of very minute teeth with larger teeth on the palatines.

The color in alcohol is bright silver, the dorsal region brown; the first dorsal is dark brown; the second dorsal is colorless on the outer portion, the rest of the fin black; the caudal has a broad basal dark brown crossbar, the remainder colorless; the other fins are all colorless; the pectoral has a trace of a dark spot at its axis.

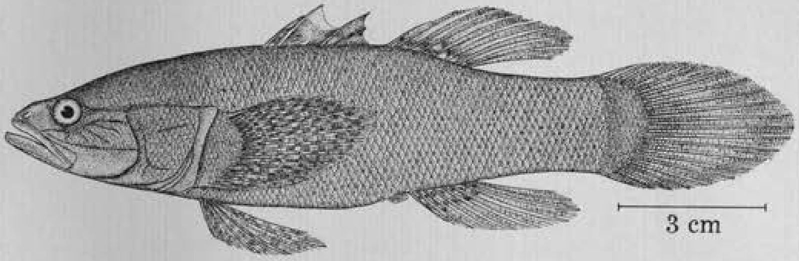
Described from the type, 35 mm long, and 5 paratypes 26 to 34 mm long, caught by electric light at the north end of Celebes.

This species differs markedly in scalation from *M. elongatus* and seems to be distinct from *M. biraræ* Duncker and Mohr.

ILLUSTRATION

PLATE 1

FIG. 1. *Lizettea pelewensis* sp. nov.
2. *Macrodontogobius wilburi* sp. nov.
3. *Lembeichthys celebesensis* sp. nov.



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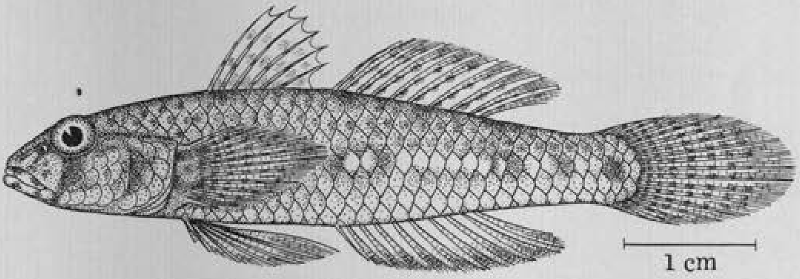

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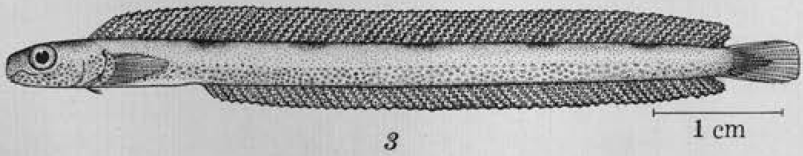

3

PLATE 1.

REVIEW OF PHILIPPINE PIGEONS, I: THE GENUS PHAPITRERON[1]

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TWO TEXT FIGURES

INTRODUCTION

The present paper is a review of the genus *Phapitreron*, based on a systematic study of the specimens in the collection of birds of the Philippine Bureau of Science, Manila.

There have been constant requests for identification of Philippine pigeons, due largely to the recent enforcements of the existing game laws and to the demand abroad for live and stuffed specimens of these birds. The confusing nomenclature in the literature of the genus prompted the writer to undertake this study.

REVIEW OF LITERATURE

Besides the papers of Temminck, Bonaparte, Sundevall, Walden, and others mentioned in synonymies of this paper, a few other publications may be considered important.

Salvadori (1893), in studying the pigeons in the collection of birds in the British Museum, enumerated the four species then known and adopted the genus *Phabotreron* (=*Phapitreron*). He described as new *Phabotreron occipitalis* with Basilan as type locality, declaring it distinct from *P. brevirostris* Tweeddale with which it was formerly identified. In addition to these two species, *P. amethystina* (Bonaparte) from Luzon, Samar, Leyte, Dinagat, Panaon, and Mindanao; *P. leucotis* (Temminck) from Luzon and Mindoro, and *P. nigrorum* Sharpe from Negros, Cebu, Guimaras, and Panay were enumerated.

The activities of Bourns and Worcester (1894) resulted in four new "species;" namely, *P. cinereiceps* from Tawitawi, *P. brunneiceps* from Basilan, *P. frontalis* from Cebu, and *P. maculipectus* from Negros.

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[1] The writer is under obligation to Director Frederick N. Chasen, of the Raffles Museum, Singapore, for going over the manuscript.

All these described species were enumerated by McGregor and Worcester (1906) in their Hand-list under *Phapitreron* and were also included by McGregor (1909) in his Manual of Philippine Birds. To the last list was added ***P. albifrons*** McGregor from Bohol and Siquijor.

Mearns (1909) described ***P. samarensis*** from the birds collected by Dr. F. S. Bourns in Samar.

In consonance with the suggestion of Hartert and Goodson (1918), Hachisuka (1930) retained *leucotis* as a species with eight subspecies. *Phapitreron amethystina* was preserved as a distinct species with six subspecies. In the present paper the arrangement used by Hachisuka is adopted, but the race *mindorensis* is considered to be a synonym of *leucotis, limucon* of *nigrorum*, and *samarensis* of *albifrons* in the *leucotis* group, while *polillensis* is regarded as a synonym of *amethystina* in the *amethystina* group. *Phapitreron cinereiceps* is rated a distinct species as originally described. Two new subspecies of *amethystina* are described.

Genus PHAPITRERON Bonaparte

Pigeons of the genus *Phapitreron* are endemic, presenting an interesting local distribution. They have not been recorded in the Batanes, the Babuyanes, or the Palawan group. The genus may be described as follows:

Arboreal pigeons, wing about 110 to 160 mm long. Sexes alike externally; their colors nearly uniform brown with a dark inferciliary line extending between the gape and nape; a wide irridescent band of purple, bluish green or both on hind neck; olivaceous gloss on the greater part of back; bill with an arched swelling anteriorly; nostrils inconspicuous in anterior aspect due to flat or seedlike covering; rectrices graduated, rounded and with gray tips which are more distinct underneath; under tail coverts gray, cinnamon buff, or sayal brown;[1] tarsus partly feathered; soles broad, that of hind toe broadest.

In this paper the genus *Phapitreron* is divided into three species.

Key to the species.

a^1. Culmen less than 20 mm.
  b^1. Band on hind neck bluish green; under tail coverts gray...... *leucotis*.
  b^2. Band on hind neck purple; under tail coverts gray........ *cinereiceps*.
a^2. Culmen 20 mm or more; band on hind neck purple.......... *amethystina*.

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[1] In this paper specific color names are from R. Ridgway, Color Standards and Color Nomenclature. Washington (1912).

SPECIES 1. PHAPITRERON LEUCOTIS (FIG. 1).

Culmen less than 20 mm; dominant color of band on hind neck metallic bluish green, under tail coverts gray. Habitat in open, noncommercial forest.

Key to the subspecies.

- a^1. Line below dark inferciliary white.
  - b^1. Forehead whitish buff.
    - c^1. Nape brick red.
      - d^1. Chin cacao brown. (Basilan.) .... *occipitalis.*
      - d^2. Chin paler than cacao brown. (Mindanao.) .... *brevirostris.*
    - c^2. Nape brown with slight tinge of reddish brown. (Samar, Bohol, Biliran, and Siquijor.) .... *albifrons.*
  - b^2. Forehead brownish gray. (Luzon, Verde, Mindoro, and Alabat.) *leucotis.*
- a^2. Line below dark inferciliary pale fulvous. (Tablas, Sibuyan, Ticao, Masbate, Panay, Negros, and Cebu.) .... *nigrorum.*

PHAPITRERON LEUCOTIS LEUCOTIS (Temminck).

Columba leucotis TEMMINCK, Pl. Col. (1823) 189.
Phabotreron leucotis SALVADORI, Cat. Bds. Brit. Mus 21 (1893) 67.
Phapitreron leucotis MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron leucotis leucotis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.
Phapitreron leucotis mindorensis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Manila, Luzon.

Specimens from Luzon, Mindoro, Verde, and Alabat were examined.

Measurements of 31 males and 26 females, in millimeters.

	Extremes.	Mean.
Wing	123–138	130.75
Tail	85–107	100.83
Culmen	14–16	14.17
Tarsus	17–19	18.00

A white line extends from about the anterior third and immediately below the dark inferciliary line and lies parallel throughout its length posteriorly. Forehead mouse gray, becoming dark with purplish gray tinge on crown and nape; chin and throat pinkish cinnamon; under tail coverts light gull gray.

In the present arrangement the race *leucotis* includes specimens from Mindoro which Hachisuka (1930) identified as *P. l. mindorensis.* The retention of *leucotis* is the result of the examination of four males and one female from Balete, Rio Baco, and one from Puerto Galera, both in Mindoro. One specimen

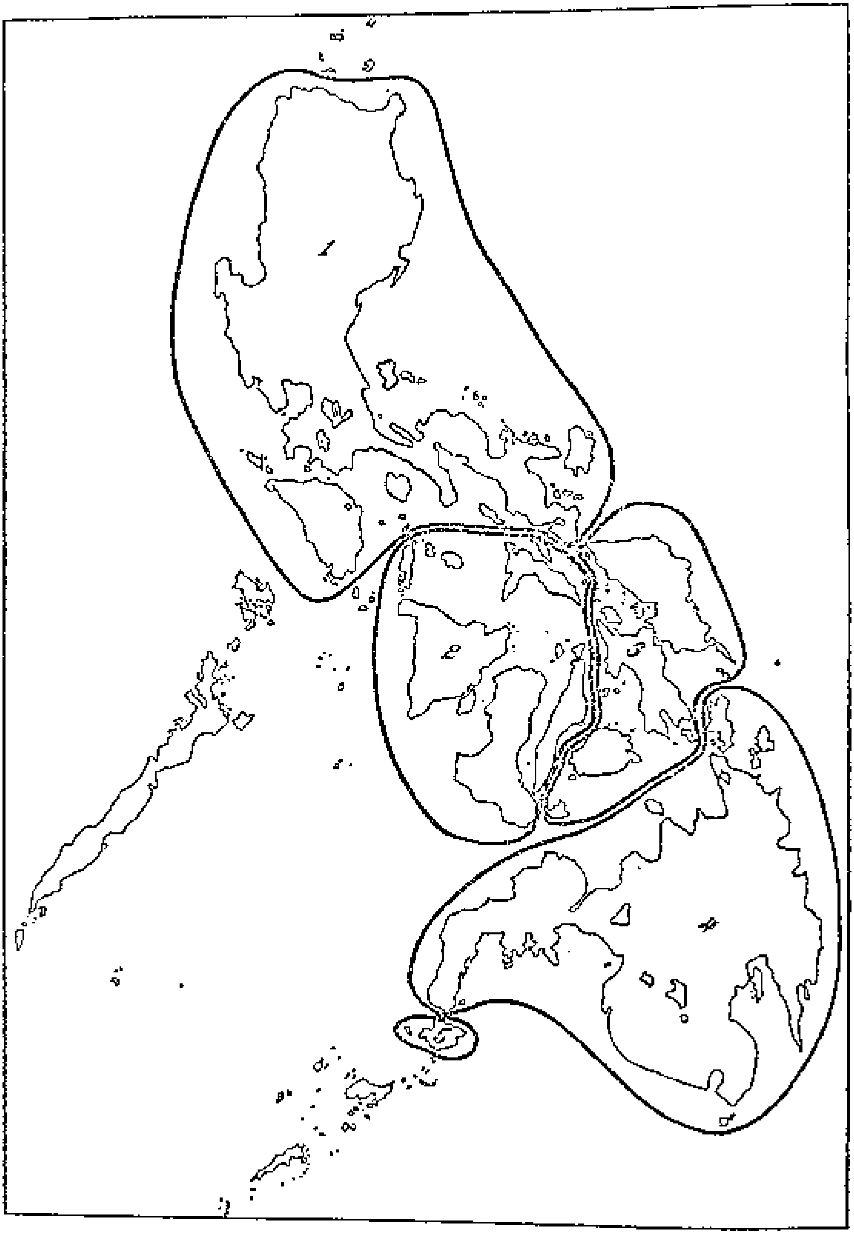

FIG. 1. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron leucotis*. 1. *Phapitreron leucotis leucotis*, 2. *Phapitreron leucotis nigrorum*, 3. *Phapitreron leucotis albifrons*, 4. *Phapitreron leucotis brevirostris*, 5. *Phapitreron leucotis occipitalis*.

(B. S. No. 4894) from Balete, Rio Baco, was made the type of the subspecies by Hachisuka. It is true that the type specimen "has more purplish shine on the back, tail, and wing coverts than the typical *leucotis* of Luzon." However, in this particular respect the holotype is different from the paratypes, thus it does not represent the typical form but indicates merely an individual variation that is not worthy of subspecific designation. The paratypes are similar in all respects to those from Luzon. In addition the characters indicated in the holotype of *P. l. mindorensis*, although slightly intense, are also obtained in a few specimens from Peñablanca, Cagayan Province, Luzon, and from Alabat Island on the east side of Luzon from which specimens of normal *P. l. leucotis* were examined.

PHAPITRERON LEUCOTIS NIGRORUM (Sharpe).

Phabotreron nigrorum SHARPE, Trans. Linn. Soc. Zool. I (1877) 346, 353.

Phapitreron nigrorum MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron leucotis limucon HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Phapitreron leucotis nigrorum HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.

Type locality: Negros.

Specimens from Negros, Panay, Cebu, Masbate, Ticao, Sibuyan, and Tablas Islands were examined.

Measurements of 13 males and 9 females, in millimeters.

	Extremes.	Mean.
Wing	120–131	125.13
Tail	86–100	94.18
Culmen	13–16	14.5
Tarsus	16–17	16.10

The white line below the inferciliary line in other races of *leucotis* replaced by pale fulvous. Forehead mouse gray as in *P. l. leucotis;* chin and throat pale ochraceous tawny.

To this race have been restored the specimens from Badajoz (nec Badajig), Tablas Islands, which Hachisuka (1930) described as *P. l. limucon.*

In separating the race *limucon* from *nigrorum* Hachisuka used the larger size of the former from Tablas as the sole criterion. He says, "the present race is nearest to *nigrorum* in coloration, but its larger size can easily be recognized while Negros and Panay specimens never seem to overlap in measurement." In this study the measurements in millimeters of 11 specimens (7 males and 4 females) from Badajoz were found to be as follows:

	Extremes.	Mean.
Wing	122–131	126.04
Tail	86–100	94.62
Culmen	14–16	14.72
Tarsus	16–17	16.31

On the other hand, the results of measuring 11 specimens (6 males and 5 females) from Sibuyan, Ticao, Masbate, Negros, and Cebu (localities of *P. l. nigrorum* according to Hachisuka), are as follows, in millimeters:

	Extremes.	Mean.
Wing	120–127	124.6
Tail	91–100	94.6
Culmen	13–16	14.27
Tarsus		16.0

From the measurements indicated above it can be seen that the wing measurements of birds from Badajoz overlap those of the birds from other places. The difference in the mean of these measurements is due to two birds from Badajoz having wing lengths of 127 and 131 mm, respectively, and to the wing of one bird from Panay with a length of 120 mm. More material from those places will surely yield uniform results.

PHAPITRERON LEUCOTIS ALBIFRONS McGregor.

Phabotreron brevirostris STEERE, List Phil. Bds. & Mammals (1890) 24.
Phapitreron albifrons MCGREGOR, Philip. Journ. Sci. § A 2 (1907) 317.
Phapitreron samarensis MEARNS, Proc. U. S. Nat. Mus. 36 (1909) 436.
Phapitreron leucotis albifrons HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.
Phapitreron leucotis samarensis HACHISUKA, Contrib. Bds. Phil. 1 (1932) 179.

Type locality: Tagbilaran, Bohol.

Specimens from Bohol, Siquijor, Biliran, and Samar Islands were examined.

Measurements of 28 males and 14 females in millimeters.

	Extremes.	Mean.
Wing	120–130	124.11
Tail	85–96	91.08
Culmen	12–15	13.87
Tarsus	16–17	16.36

White line below dark inferciliary as in *P. l. leucotis*. Resembling *P. l. brevirostris* and *P. l. occipitalis* but with less purple gloss on breast. Forehead pale pinkish buff blending gradually into mouse gray of crown; nape paler than sorghum brown. Chin pale tilleul buff gradually becoming light brown on throat.

Upon careful examination of 14 specimens from Samar (Wright), 2 from Biliran, 19 from Bohol (Tagbilaran, Sevilla, and Guindulman), and 2 from Siquijor the writer was convinced that all these birds belong to one race. Again, variable characters may lead to the establishment of a new race when only a few specimens are examined. This can be solved only by examination of a number of specimens from both places. The color of the underparts of the pigeons examined from Wright ranges gradually from brown in those described by McGregor (1907) to those with a medium shade of coppery reflections typified by *P. samarensis* Mearns (1909). The specimens from Siquijor and Bohol possess the same characters. Similar overlapping of colors on the upper surface was observed in all the specimens examined. Because *albifrons* (1907) antedates *samarensis* (1909),, the latter is held a synonym of the former. It is very probable that specimens from Leyte belong to this race.

PHAPITRERON LEUCOTIS BREVIROSTRIS (Tweeddale).

Phabotreron brevirostris TWEEDDALE, Proc. Zool. Soc. (1877) 549.

Phapitreron brevirostris MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron leucotis brevirostris HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.

Type locality: Pasonanca (nec Pasnanaca), Zamboanga, Mindanao.

Specimens from Agusan, Cotabato, Davao, and Zamboanga were examined.

Measurements of 7 males and 18 females, in millimeters.

	Extremes	Mean.
Wing	115–129	121.76
Tail	85–96	91.20
Culmen	15–16	15.39
Tarsus	14–16	15.09

White line below dark inferciliary as in *P. l. leucotis*. Resembles closely *P. l. occipitalis* except the nape which is dull Indian purple. The chin is very slightly paler than the cacao brown of *occipitalis*.

PHAPITRERON LEUCOTIS OCCIPITALIS (Salvadori).

Phabotreron brevirostris TWEEDDALE, Proc. Zool. Soc. (1879) 73.
Phabotreron occipitalis SALVADORI, Cat. Bds. Brit. Mus. 21 (1893) 68.
Phapitreron occipitalis MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron leucotis occipitalis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Basilan.

Measurements of 2 males and 5 females, in millimeters.

	Extremes.	Mean.
Wing	119–125	121.28
Tail	84–93	87.28
Culmen	15–16	15.85
Tarsus		15.00

White line below dark inferciliary as in *P. l. leucotis*. Similar to *brevirostris* except the nape which is hydrangea red. Chin cacao brown.

SPECIES 2. PHAPITRERON CINEREICEPS

Culmen less than 20 mm, dominant color of band on hind neck purple; under tail coverts gray. Habitat dense, virgin forest.

PHAPITRERON CINEREICEPS (Bourns and Worcester).

Phabotreron cinereiceps BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 8.
Phapitreron cinereiceps MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron amethystina cinereiceps HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Tawitawi.

Cotype (female) examined. "Top of head, nape and sides of neck clear ashy gray, slightly washed with rufous on forehead; hind neck amethystine as in *P. amethystina;* back, rump and upper tail-coverts brown with bronze reflections, the tail coverts slightly more ruddy than back." Kaiser brown of breast less intense on chin and throat. Under tail coverts gray. General appearance of upper surface closer to *P. amethystina* than to *P. leucotis*, under surface vice versa. Wing, 131 mm; tail, 98; culmen, 16; tarsus, 15.

SPECIES 3. PHAPITRERON AMETHYSTINA (FIG. 2)

Culmen 20 mm or over, dominant color on back purple, under tail coverts gray or cinnamon. Habitat dense, virgin forest.

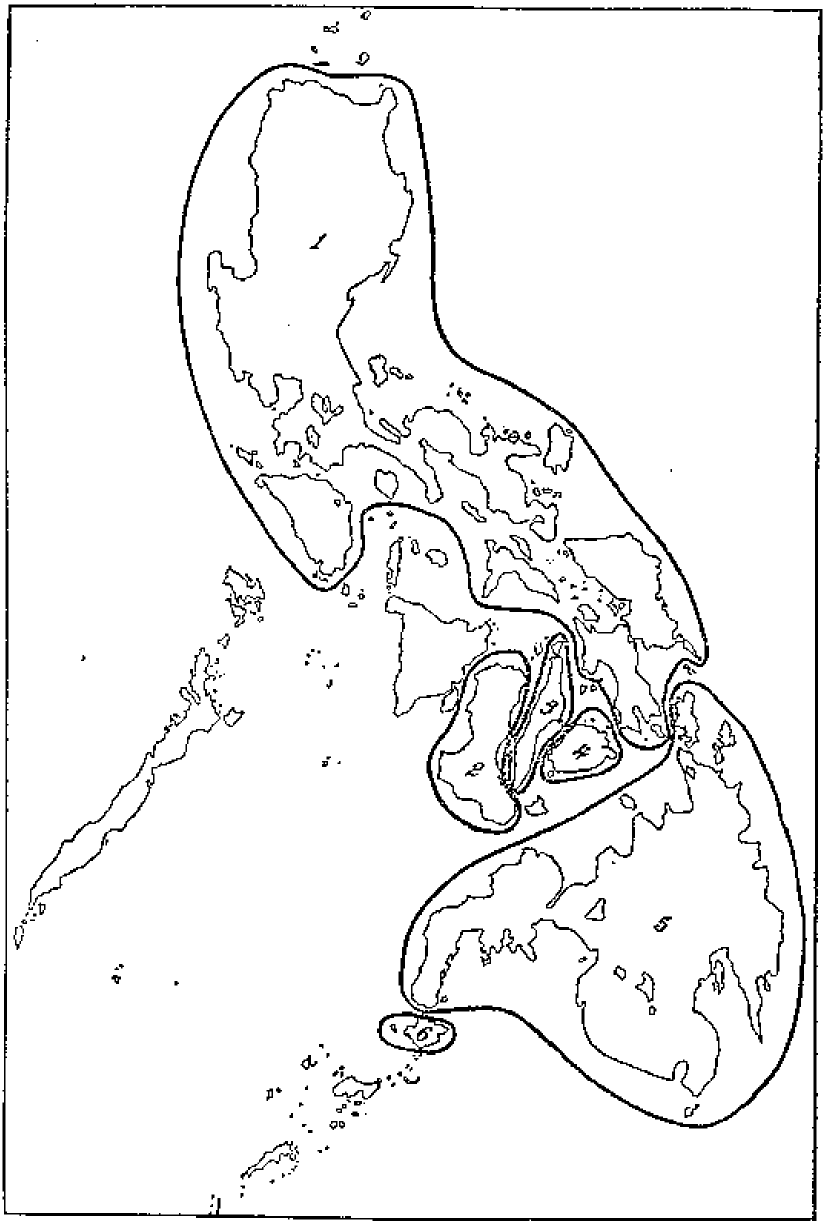

FIG. 2. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron amethystina*. 1. *Phapitreron amethystina amethystina*, 2. *Phapitreron amethystina maculipectus*, 3. *Phapitreron amethystina frontalis*, 4. *Phapiteron amethystina celestinoi*, 5. *Phapitreron amethystina mindanaoensis*, 6. *Phapitreron amethystina brunneiceps*.

Key to the subspecies.

a^1. Under tail coverts cinnamon.
  b^1. Under surface light gray.
    c^1. Tail less than 100 mm. (Basilan.) .... *brunneiceps.*
    c^2. Tail more than 110 mm. (Negros.) .... *maculipectus.*
  b^2. Under surface brown.
    c^1. Neck dark violet, in adults distinctly sheeny.
      d^1. Under tail coverts sayal brown. (Bohol.) .... *celestinoi.*
      d^2. Under tail coverts cinnamon buff. (Surigao, Agusan, Davao.) *mindanaoensis.*
    c^2. Neck paler than violet, in adults sheeny against light. (Luzon, Polillo, Alabat.) .... *amethystina.*
a^2. Under tail coverts gray. (Cebu.) .... *frontalis.*

PHAPITRERON AMETHYSTINA AMETHYSTINA Bonaparte.

Phapitreron amethystina BONAPARTE, Compt. Rend. 40 (1855) 214.
Phaps amethystina GRAY, List Bds. Brit. Mus. (1856) 62.
Chloroenas amethystina SCHLEGEL, Mus. Pays-Bas. (1873) 80.
Phabotreron amethystina WALDEN, Trans. Zool. Soc. 9 (1875) 214.
Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.
Phapitreron amethystina polillensis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Philippines. Bonaparte did not indicate from which part of the Archipelago his specimen was obtained. Walden (1875), in recording *amethystina* and *P. leucotis* from Luzon, Guimaras, and Negros, was the first to indicate a specific locality for the species. The same author (p. 125) expressed an idea that the specimen described by Bonaparte perhaps came from Luzon. In the absence of evidence to the contrary, and for purposes of the present study, Luzon is taken as the type locality of the subspecies *amethystina.* Hachisuka (1930) appears to have the same opinion.

Specimens from Luzon, Polillo, and Alabat Islands were examined.

Measurements of 13 males and 14 females, in millimeters.

	Extremes.	Mean.
Wing	137–153	144.81
Tail	100–119	109.18
Culmen	20–22	21.07
Tarsus	19–23	20.95

White line, nearly pale pinkish buff, equal in length with dark inferciliary, lying parallel and below this from gape to nape; hind neck manganese violet, sheeny when held toward the light; under tail coverts cinnamon buff, the tips of feathers in middle abdomen of the same shade.

In this study only specimens from Luzon, Alabat, and Polillo Islands are included in the race *amethystina*. It is very likely that the birds from Samar belong to this race as one young specimen I studied from Wright tends to show, but final decision should await examination of more material. It is also probable that specimens from Masbate and Leyte belong to this race.

In making *P. a. polillensis* Hachisuka (1930) a synonym of the present race, I base my action on specimens from Lucban, Tayabas. Six of 14 birds from Polillo are distinctly larger than the rest. The specimens from Lucban are also large. The color of the head is the same as in other races of this species except *maculipectus* and *brunneiceps*. The type of *P. a. polillensis* (B. S. 7037) is similar to the birds from Luzon except that it is larger than some of them. The paratypes, however, are also smaller than the holotype.

PHAPITRERON AMETHYSTINA MACULIPECTUS (Bourns and Worcester).

Phabotreron maculipectus BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 10.

Phapitreron maculipectus MCGREGOR and WORCESTER, Hand-List Bds. Phil. Is. (1906) 10.

Phapitreron amethystina maculipectus HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Negros.

Specimens from Occidental Negros were examined.

Measurements of 6 males and 3 females, in millimeters.

	Extremes.	Mean.
Wing	142–148	144.85
Tail	118–127	123.14
Culmen	20–22	20.98
Tarsus	21–23	22.14

White stripe below dark inferciliary as in *P. a. amethystina*. Below white stripe is another dark stripe. "Under surface ashy gray. Cheeks fulvous brown; chin and throat more ruddy brown; breast clear ashy gray, each feather having an edging distinctly lighter than its center, producing a beautiful mottled appearance," middle abdomen pale cinnamon buff, intermediate between breast and undertail coverts. Undertail coverts cinnamon buff.

PHAPITRERON AMETHYSTINA FRONTALIS (Bourns and Worcester).

Phabotreron frontalis BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 10.

Phapitreron frontalis MCGREGOR and WORCESTER, Hand-List Bds. Phil. Is. (1906) 10.

Phapitreron amethystina frontalis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Cebu.

Cotype examined.

One male, wing, 144 mm; tail, 112; culmen, 20; tarsus, 18.

Line below dark inferciliary indistinct; hind neck pansy violet with royal purple gloss. Under surface olive brown as in *P. a. maculipectus*, intermediate between *P. a. brunneiceps* and *P. a. celestinoi*. "Under-tail coverts ashy gray, slightly tipped with fulvous."

PHAPITRERON AMETHYSTINA BRUNNEICEPS (Bourns and Worcester).

Phabotreron brunneiceps BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 9.

Phapitreron brunneiceps MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron amethystina brunneiceps HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Basilan.

Two males, wing, 134, 137 mm; tail, 92, 99; culmen, 20, 21; tarsus, 16, 17.

"Amethystine spot on hind neck less blue than in *P. a. amethystina*. Chin and throat grayish fulvous; breast pearly ash." Middle abdomen, flanks, thighs, and under tail coverts cinnamon buff like the under tail coverts of *P. a. maculipectus*.

PHAPITRERON AMETHYSTINA CELESTINOI subsp. nov.

Phapitreron amethystina MCGREGOR, Philip. Journ. Sci. § A 2 (1907) 317.

Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type.—Male adult, No. 11496, Bureau of Science collection, Sevilla, Bohol; March 21, 1906; A. Celestino and M. Canton, collectors.

Subspecific characters.—Like typical *amethystina* from Luzon, Mindoro, Polillo, Alabat, and Samar, but with a darker shade of purple on the hind neck. From specimens of *P. amethystina* from Agusan, Surigao, and Davao, which it also very closely resembles, it differs in the color of the under tail coverts which is cinnamon. From *P. a. maculipectus* of Negros, *P. a. brunneiceps* of Basilan, and *P. a. frontalis* of Cebu, it differs distinctly in the darker color of the underparts.

Range.—The distinctness of the races found in Negros, Cebu, Samar, and northern Mindanao suggests the probability that this form is confined to Bohol.

Description of type.—General color brown; forehead drab gradually changing into fuscous of crown and nape; circumocular area including cheeks and auriculars naked forming a subconical appearance that rests on a dark inferciliary line that extends from gape to nape. Narrower pale ochraceous buff line lies beneath dark inferciliary, the two lines running the same length. Hind neck prune purple with sheeny dark violet shade. Rest of upper surface bister with greenish clove brown gloss. Chin and throat army brown; breast, flanks, and thighs clove brown; abdomen slightly paler than breast, fringes with a wash of cinnamon buff; under tail coverts sayal brown, distal fifth of tail feathers pale olive-gray underneath. Wing, 146 mm; tail, 120; culmen, 21; tarsus, 20.

This subspecies is named for the late Mr. Andres Celestino, Filipino ornithological collector, through whose hands many Philippine birds passed before becoming known to science. Those birds are now scattered in many museums all over the world.

PHAPITRERON AMETHYSTINA MINDANAOENSIS subsp. nov.

Phabotreron amethystina TWEEDDALE, Proc. Zool. Soc. (1877) 832.
Phapitreron amethystina MCGREGOR, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type.—Male adult, No. 12362, Bureau of Science collection; Butuan, Agusan, Mindanao; September 26, 1907; A. Celestino, collector.

Subspecific characters.—Resembles closely *P. a. celestinoi* of Bohol, but the under tail coverts cinnamon buff. From typical *amethystina* of Luzon, Mindoro, Polillo, Alabat, and Samar it differs only in the degree of purple of hind neck which has a darker shade of blue. Hind neck of specimens from Luzon, etc., has a darker shade of red. Like *P. a. celestinoi*, it differs distinctly from *P. a. maculipectus* of Negros, *P. a. brunneiceps* of Basilan, and *P. a. frontalis* of Cebu in the darker color of underparts.

TWEEDDALE, ARTHUR, Marquis of. Reports on the collections of birds made during the voyage of H. M. S. "Challenger"—No. II. On the birds of the Philippine Islands (1877) 549–550.

TWEEDDALE, ARTHUR, Marquis of. Contributions to the Ornithology of the Philippines.—No. XII. On the collection of birds made by Mr. A. H. Everett in the island of Basilan (1879) 73.

WALDEN, ARTHUR, Viscount. A list of birds known to inhabit the Philippine Archipelago. Trans. Zool. Soc. London 9 Part 2 (1875) 214.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron leucotis*.
  1. Phapitreron leucotis leucotis.
  2. Phapitreron leucotis nigrorum.
  3. Phapitreron leucotis albifrons.
  4. Phapitreron leucotis brevirostris.
  5. Phapitreron leucotis occipitalis.

2. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron amethystina*.
  1. Phapitreron amethystina amethystina.
  2. Phapitreron amethystina maculipectus.
  3. Phapitreron amethystina frontalis.
  4. Phapitreron amethystina celestinoi.
  5. Phapitreron amethystina mindanaoensis.
  6. Phapitreron amethystina brunneiceps.

NEW PHILIPPINE FRUIT PIGEONS

By CANUTO G. MANUEL

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ONE PLATE

The two new fruit pigeons that are described in this paper were noted by the writer in the collection of birds of the Philippine Bureau of Science, Manila.

An examination of fruit pigeons from the different islands of the Archipelago resulted in the discovery of some interesting forms. While conclusions on other materials cannot as yet be drawn on account of insufficiency of specimens, I am convinced that the black-chinned fruit pigeons from Batan, Camiguin, and Calayan Islands of northern Philippines represent a distinct race, which I propose to call—

LEUCOTRERON LECLANCHERI LONGIALIS subsp. nov.

Type.—Male, No. 6402, Bureau of Science collection; Batan Island, Philippine Islands, May 31, 1907; collected by R. C. McGregor and A. Celestino.

Characters.—Closely similar to *Leucotreron leclancheri leclancheri*, but wings and tail distinctly longer.

Wing, 164 mm; tail, 118; culmen, 18; tarsus, 25; middle toe and claw, 35.

Material examined.—*Leucotreron leclancheri leclancheri*, 14 specimens from Luzon Island measured:

Wing, 146.64 (138–156) mm; tail, 106.46 (100–110); culmen, 14.64 (14–16); tarsus, 20.92 (20–23); middle toe and claw, 29.28 (27.5–32).

Another fruit pigeon belonging to a new subspecies is represented by two specimens from northern Luzon. The diagnosis of this new race follows.

NEOLEUCOTRERON MERRILLI FAUSTINOI subsp. nov. Plate 1.

Type.—Male, No. 28358, Bureau of Science collection; Mount Tabuan at about 1,000 meters, Cagayan Province, Luzon, Philippine Islands, May 21, 1929, collected by Francisco S. Rivera.

Characters.—In general appearance similar to *Neoleucotreron merrilli merrilli* (McGregor) but with an occipital patch of vandyke red.

Measurements.—Wing, 168 mm; tail, 121.5; culmen, 15; tarsus, 26.5; middle toe and claw, 36.

Remarks.—The genus *Neoleucotreron* was recently established by Hachisuka[1] who used the decomposed and lengthened barbules of the secondaries as generic characters. These criteria, however, were first noted by McGregor[2] who suggested *Neoleucotreron* for a subgeneric designation.

This subspecies is named for the late Dr. Leopoldo A. Faustino, for many years palæontologist of the Bureau of Science, Manila.

[1] The Birds of the Philippine Islands. London 1 (1932) 188.

[2] Philip. Journ. Sci. § D 13 (1918) 2.

ILLUSTRATION

PLATE 1. *Neoleucotreron merrilli faustinoi* subsp. nov., male. (Drawn by M. Ligaya.)

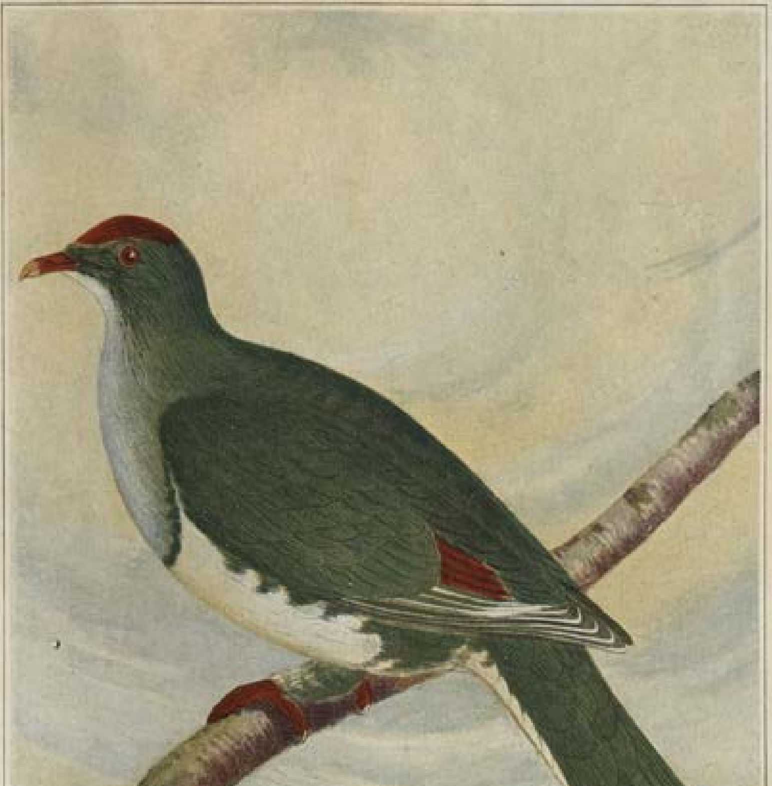

PLATE 1.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American conference on birth control and national recovery. Washington, D. C., 1934. Biological and medical aspects of contraception; papers and discussions presented at the Conference, at the Mayflower, Washington, D. C., January 15, 16, 17, 1934. Edited by Margaret Sanger. Washington, D. C., National committee on federal legislation for birth control, 1934. Paper, 135 pp. Price, $1.15.

American society for testing materials. A. S. T. M. standards on refractory materials. Philadelphia, Pa., American society for testing materials, 1935. 143 pp. Price, $1. To nonmembers, $0.75.

American society for testing materials. Symposium on paint and paint materials. Philadelphia, Pa., American society for testing materials, 1935. 150 pp. Price, paper cover, $1.25; cloth, $1.50.

BLAKESLEE, GEORGE H. Conflicts of policy in the Far East. New York, Foreign policy association, 1934. Paper, 56 pp. Price, $0.25.

Chemical foundation, incorporated. Future independence and progress of American medicine in the age of chemistry, by a committee of American scientists. New York city, The Chemical foundation, 1921. 80 pp. Price, $0.50.

GALLOWAY, THOMAS W. Sex and social health; a manual for the study of social hygiene. New York, The American social hygiene association, 1924. 361 pp. Price, $2.50.

GIBSON, THOS. W. The mining laws of Ontario and the Department of mines. Toronto, H. H. Ball, 1933. 141 pp.

GREGORY, Sir RICHARD A. Discovery; or, The spirit and service of science. New York, The Macmillan Co., 1929. 347 pp. Price, $2.

GUILLERMIE, A. Le chauffage par les combustibles liquides. Paris et Liege, Librairie polytechnique, Ch. Beranger, 1935. 394 pp.

JOSE, RICARDO A. R. Investigaciones sobre la eufonia en el idioma tagalo; la sinfonía de las consonantes y la antigua clasificación de las letras tagalas. Manila, Cecilio press, 1934. 32 pp.

KAPUR, S. N. A manual on the air seasoning of Indian timbers. Delhi, Manager of publications, 1934. 113 pp.

KALSEM, MILLIE E. The use of rice on the hospital menu. Chicago, Illinois, Cook county hospital, 1935. 20 pp.

LAYTON, T. B. Catalogue of the Onodi collection in the museum of the Royal college of surgeons of England. London, Royal college of surgeons of England, 1934. 131 pp.

League of nations. Health organization. European conference on rural hygiene. Geneva, 1931. vols. 1 and 2.

League of nations. Health organization. Protective measures against dangers resulting from the use of radium, Roentgen and ultra-violet rays, by Prof. Hermann Wintz . . . with the assistance of Privatdozent Walther Rump. Geneva, 1931. 114 pp. Price, $0.75.

League of nations. Health organization. The standardization of dysentery serum. By K. Shiga, H. Kawamura and K. Tsuchiya. The Kitasato institute for infectious diseases, Tokyo, Japan. Geneva, 1924. I–II, report.

League of nations. Organisation d'hygiene. Les enquêtes entreprises en Amerique du Sud sur la mortalite infantile. Montevideo, Impr. de Dornaleche frères, 1931. 237 pp.

MONTAGUE, JOSEPH F. I know just the thing for that! New York, The John Day Co., 1934. 265 pp. Price, $2.

MORTON, JOHN N. (comp.) Re-union booklet; original Company F of the 30th United States infantry, 1901–1904; history, letters, and stories depicting army days in the Philippines as compiled by J. N. Morton, 1933. Springfield, Mo., J. N. Morton, 1934. 136 pp. Price, $2.

OKABE, TOYOKITI. Gas metabolism of kidney tissue in vitro. Kumamoto medical college, 1934.

OWINGS, CHLOE. Women police; a study of the development and status of the women police movement. New York, F. H. Hitchcock, 1925. 337 pp. Price, $2.50.

PENROSE, E. F. Population theories and their application with special reference to Japan. California, Stanford University, Food research institute, 1934. 347 pp.

Philadelphia child health society. Nutrition program and teaching outline; developed for use in the health centers and clinics of the Division of child hygiene, Dept. of public health, Philadelphia, by Anna de Planter Bowes. 2d ed. Prepared and published by the Philadelphia child health society. Philadelphia, Pa., 1934. 156 pp. Price, $1.

Philippine Islands. Bureau of Education. Guide in health education for elementary schools, for supervisors, principals, teachers and teacher-nurses. Manila, Bureau of Printing, 1934. 225 pp.

RIVERS, THOMAS M. Autonomic diseases; or, The rheumatic syndrome. Philadelphia, Dorrance & Co., 1934. Price, $3.

ROOT, MRS. GRACE C. Women and repeal; the story of the Women's organization for national prohibition reform. New York, Harper & brothers, 1934. 217 pp. Price, $1.50.

SASTRI, HIRANANDA. A guide to Elephanta. Delhi, Manager of publications, 1934. 70 pp.

SIZELOVE, OLIVER J. Platers' guidebook; revised solutions. 4th ed. New York, The Metal industry publishing co., 1935. 64 pp. Price, $0.25.

SPAULDING, EDITH R. An experimental study of psychopathic delinquent women. New York, Published for the Bureau of Social Hygiene, by Rand McNally and Co., 1923. 368 pp.

The Rubber growers' association. Rubber and agriculture. London, The Rubber growers' association, 1934. 64 pp.

League of nations. Health organization. Protective measures against dangers resulting from the use of radium, Roentgen and ultra-violet rays, by Prof. Hermann Wintz . . . with the assistance of Privat-dozent Walther Rump. Geneva, 1931. 114 pp. Price, $0.75.

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SPAULDING, EDITH R. An experimental study of psychopathic delinquent women. New York, Published for the Bureau of Social Hygiene, by Rand McNally and Co., 1923. 368 pp.

The Rubber growers' association. Rubber and agriculture. London, The Rubber growers' association, 1934. 64 pp.

REVIEWS

Symposium on Paint and Paint Materials. American Society for Testing Materials, Philadelphia, Pa., 1935. 150 pp. Price, $1.50.

This publication practically covers the most important points of the paint industry. It begins with a discussion of the future progress of the paint business, through the efforts of research workers and producers of useful materials. Then the subject of paint specifications is treated in a comprehensive manner, and certain advantages and disadvantages of purchasing by specifications are pointed out. The application of paints to railway passenger cars and the technical aspects of testing paints, varnishes, and lacquers are well presented and thoroughly discussed.

The rest of the symposium is devoted to technical descriptions of the characteristics, varieties, and preparation of different paint materials, used as vehicles and pigments. The symposium, therefore, may be regarded as an important source of up-to-date information on the subject of paint and paint materials, and is a valuable contribution to the progress of the paint industry.—R. H. A.

The Illinois Board of Public Welfare Commissioners. The Effort for Mental Health in the State of Illinois. Journal Printing Co., Springfield, Ill., 1932. Paper, 102 pp.

The Illinois Board of Public Welfare Commissioners makes a general statement on the development of psychiatry and mental hygiene in the state of Illinois. The board recognizes notable advances and contributions to this object, but states that such gains are not always maintained and efforts are not supported by sufficient consideration of the general task.

The general conception of the plan of organization of responsibility and functions of the various agencies is illustrated in charts. The University as a center includes departments of psychiatry and general medicine, and has the function of training workers for the application of existing knowledge in all fields and for research. The functions of agencies outside the university are divided mainly into recognition of mental diseases, therapy of mental diseases, prevention of mental diseases, and promotion of mental health. The activities of each of the participating agencies are given in this report.—O. G.

Standards on Electrical Insulating Materials. American Society for Testing Materials, Philadelphia., Pa., 1935. 311 pp. Price, $1.75.

The publication seems to give the best information available at present on the methods of testing electrical insulating materials.

The different aspects of the subject are discussed in a comprehensive manner, and some of the methods and the apparatus used, as well as their arrangement, are illustrated by means of diagrams, sketches, or photographs.

The standard specifications and methods of testing compiled in this publication cover the following materials: Varnishes, solid filling and treating compounds, molding powders, sheet and plate materials, laminated tubes and round rods, natural mica, flexible varnished tubing, friction tape, rubber insulating tape, rubber gloves, rubber matting, electrical cotton yarns, silk and cotton tapes, pasted mica, and slate; also, black bias-cut varnished tape; asbestos yarns, tape and roving; untreated paper; electrical porcelain; insulating oils.

The book covers the results of the extensive research and investigation work done by Committee D–9, of the American Society for Testing Materials, in charge of electrical insulating materials.—R. H. A.

Diseases of the Skin. By R. L. Sutton and R. L. Sutton, Jr. 9th ed. rev. and enl. C. V. Mosby Co., St. Louis, Mo., 1935. 1,433 pp. (illustrated). Price, $12.50.

This book needs no introduction to lecturers and practitioners. The present edition has been enriched with new photographs and photomicrographs and presents additional information on pyodermia gangrænosum, pili torti, telangiectasia macularis, eruptiva perstans, cutis rhomboidales muchæ, cephalosporiasis, pseudoatrophoderma colli, hidrosadenitis axillaris, necrobiosis lipoidica diabeticorum, anaphylactic gangrene, granuloma fissuratum, lingual tonsillitis, and other skin diseases described by the junior author. The section on coccidioidal granuloma, tularemia, and the treatment of syphilis have also been revised.—O. G.

American Society for Testing Materials. Standards on Preservative Coatings for Structural Materials. A. S. T. M., Philadelphia, Pa. 387 pp. Price, $1.75.

This work is a compilation of standard specifications, methods of testing, and definitions on preservative coatings (other than metallic coatings) for structural materials. It is the latest work of the Society's Committee D-1 and covers several standards having reference to various types of pigments, oils, and thinners, varnish and varnish materials, lacquers and miscellaneous materials and subjects. New standard specifications for certain types of pigments, such as titanium compound pigments, high zinc sulphide lithopone, blue lead basic sulphate, amyl acetate, etc., are also included. The methods of tests, which cover comparative hiding power, tinting strength of white pigments, and tinting strength of dry color pigment and paste, are very interesting. The pamphlet is of great value to paint manufacturers and consumers and to all interested in paints and paint materials.—R. H. A.

Testing Precious Metals; gold, silver, palladium, platinum; identifying, buying, selling. By C. M. Hoke. 2d ed. rev. and enl. Jewelers Technical Advice Co., N. Y., 1935. Paper, 60 pp. Price, $1.

This book should be of interest to those who deal in precious metals. Part I describes in plain language the use of the touchstone, and simple chemical and other physical tests for the purpose of identifying and estimating the approximate fineness of gold, silver, platinum alloys, and other precious metals.

Part II gives useful suggestions regarding the method of evaluating old jewelry, while Part III gives the meanings of common terms used in connection with precious metals and the composition of well-known alloys.—F. D. R.

Standard Methods for Testing Petroleum and Its Products. Institution of Petroleum Technologists, London, W. C., Great Britain. 228 pp.

This publication is the latest contribution of the Institution of Petroleum Technologists to the petroleum industry. It covers practically all standard methods for sampling and testing petroleum materials, describing in detail the different apparatuses used and the various steps taken in the preparation of the tests. It also discusses the points of the methods that have the greatest bearing on results. The publication is profusely illustrated with sketches showing the relation between different parts of apparatus used in the most important tests. In order to avoid possible misunderstanding regarding the significance of the results of tests, instructions are given on how the results should be expressed and interpreted.

The work is well indexed and properly arranged, and may be regarded as a valuable reference book for manufacturers and users of petroleum products.—R. H. A.

A Manual of the Common Invertebrate Animals Exclusive of Insects. By H. S. Pratt, Haverford College. Revised edition. P. Blakiston's Sons & Co., Inc., Philadelphia, Pa., 1935. 854 pp. 974 figs. Price, $7.50.

The revised edition of this important and well-known book on the classification of the Invertebrata is a great improvement over the first edition, which appeared in 1916. Many of the larger subdivisions, in fact, even entire phyla, have been rewritten in coöperation with, or with the assistance of, specialists. The nomenclatures of the species treated are brought up to date and errors of fact in the descriptions in the early edition are corrected. Many of the animals included are so cosmopolitan in distribution that although the text is perhaps primarily intended for the American student of zoölogy it can be used anywhere.

Small, but very important, groups of animals like the ctenophores, nemertineans, trochelminthes, bryozoans, and brachiopods are always a source of difficulty to a building systematist. A student working in the field or in the laboratory often meets these animals of the so-called "indefinite systematic position" and unless he has a book of this sort for ready reference he often finds himself lost. The prominence given to these small groups is an excellent feature of the text. The enumeration of the families and genera is preceded by morphological descriptions of the phylum, classes, and orders, together with definitions of terms most often used. These descriptions facilitate the use of the synoptic keys with which the book is amply supplied. The book is replete with schematic but non-the-less good illustrations which in many cases allow one to place his animal to the genus without much difficulty. The text is well adapted for use in classes of systematic marine invertebrates. It is handy in any marine laboratory where beginning students in systematic zoölogy are taught to identify collected material.—H. A. R.